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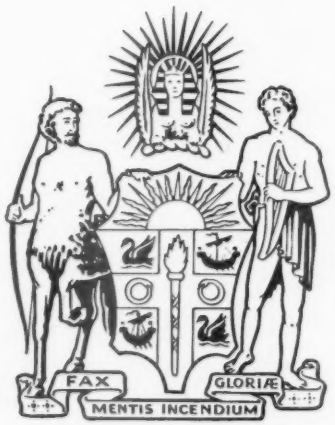

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TALCUM POWDER GRANULOMA

By Neil Johnson

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THE dangers of the use of talc when employed as a surgical glove powder have been recognized for twenty years; an extensive literature has accumulated on the subject emphasizing this point and yet talc powder is still frequently used for this purpose in major hospitals. Talc, when introduced into the tissues, will produce a variety of lesions and the concept, that it may be used with impunity provided that no serous cavity is opened, is untenable.

The main purpose of this paper is to re-emphasize the hazard of the continued and probably (in many cases) careless use of talc particularly now that a satisfactory starch powder substitute is readily available.

Chemically, talc consists mainly of hydrated magnesium silicate of formula $3MgO4SiO_2H_2O$. Its physical state is that of a fine powder which, on microscopy, proves to be a mixture of amorphous and crystalline material, only the crystalline part being refractile. It is proposed, at this point, to discuss briefly the range of lesions which may be produced by this silicate.

General Characters of Talc Lesions

A. In extra-peritoneal sites, a disturbance due to talc may declare itself either in the immediate or in a remote post-operative period. Immediately following operation delayed wound healing or persistent sinus formation may be seen (Eiseman *et alii*, 1947).

Should the talc-contaminated wound heal satisfactorily the patient may still be faced with the possibility of one of a variety of lesions. These may occur after an interval of a few weeks or may be delayed for many years. The most frequent manifestation is a local granuloma and this is usually mis-diagnosed. Should it follow an operation for malignancy the serious diagnostic error of recurrence of the tumour may be made.

Several cases are recorded where talc, located around a nerve, has given rise to fibrosis and swelling which causes pain in the distribution of that nerve.

B. When talc is introduced into a serous cavity two types of lesion may be produced:

(i) multiple plaques form over the serous surface — the surgeon on observing these, almost invariably suggests carcinomatosis or tuberculosis (Smith, 1948; Seelig, 1944);

(ii) adhesions occur and frequently these may be sufficiently gross as to give rise to intestinal obstruction.

A patient may therefore be subjected to many subsequent operations. Fatal cases are not at all uncommon (Swingle, 1948; Walker, 1948).

C. In the female, talc introduced into the peritoneal cavity may find its way into the Fallopian tubes. Here it causes the usual chronic inflammatory reaction, occluding the tubes and giving rise to symptoms of chronic pelvic inflammation and sterility (Roberts, 1947).

D. Other instances are recorded where talc has been inhaled, has entered the conjunctiva (McCormick, *et alii*, 1949) and has entered wounds by way of ward dressings.

These lesions have been observed with a disconcerting frequency, Ross and Lubbitz (1949) reporting a series of 33 cases in 2,000 consecutive examinations of routine surgical specimens.

HISTORICAL SURVEY

The observation that a granuloma may follow the implantation of silica into the tissues has been made for many years. Shattock, in 1916, reported a case of granuloma formation in the lower lip. This occurred eleven years after the implantation of sand into a wound at that site. On section, this granuloma showed typical giant cell systems enclosing doubly-refractile silica crystals.

Martin, in 1881, was the first to demonstrate the effect of implantation of foreign material into serous cavities. He introduced lycopodium spores into the peritoneal cavity of an experimental animal and noted adhesion and granuloma formation. Roth (1923) cited the first clinical case of adhesion formation following the introduction of lycopodium powder into the human peritoneum.

Antopol (1933), in addition to recording five cases of lycopodium granuloma, described the first case of talc granuloma in the human subject.

The wide variety of lesions attributable to talc soon became evident; Fienberg (1937) recorded a series of cases including recurrent nodules following thyroidectomy and a nodule following the excision of a carcinoma of the lip. In this paper Fienberg pointed out the value of Nicol prisms when investigating an obscure granuloma. He also carried out experimental work in this field—being the first to inject a suspension of talc into the peritoneal cavity of adult mice. This, he found, resulted in the formation of both granulomata and adhesions.

German (1943) repeated these experiments using rabbits as his test animals. He concluded that talc, whilst giving rise to many granulomata, would not cause adhesion formation. There is apparently some species variation in the susceptibility of the tissues to damage by talc. The evidence indicates that, in the human peritoneum, talc may cause extensive adhesion formation. Mackey and Gibson (1948) record a case in which the peritoneal cavity was reopened thirteen days after a laparotomy; extensive adhesion and granuloma formation was found and section showed these lesions to contain large amounts of talc.

Seelig and his co-workers (1943, 1944) give an excellent review of the literature to that date and then describe a series of experiments designed to demonstrate the suitability of a talc substitute. After testing many powders they concluded that potassium bitartrate was the best alternative available at that time.

Further excellent reviews are given by Roberts (1947) and Eiseman (1947). Eiseman reviews 37 cases and suggests four criteria for the diagnosis of talc granuloma. These are:—

(i) doubly refractile material must be present;

(ii) the crystals must have the morphology of talc;

(iii) a typical foreign body reaction must be present;

(iv) there must be a compatible clinical history.

Lichtman *et alii* (1946) examined a large series of abdominal scars and in many of them found evidence of included talc. In only a few, however, were actual granulomata present.

There have been many attempts to explain this irregularity of response to talc. Experimental work by Saxen and Tuovinen (1948) indicates that tissue trauma may play a part. These workers implanted talc into the peritoneal cavity and into the thigh muscles of adult rats. If a large quantity of talc were used, granulomata and adhesion formation resulted in almost every case. If, however, minute quantities of talc were used, a minimal reaction would follow and no granuloma result. They then traumatized the tissues by pressure with forceps, before

introducing the talc. It was then found that minute quantities of talc produced well-defined granuloma and adhesions, while the lesions caused by larger quantities were increased in extent.

Key and Ramsay (1950), in reporting a series of talc granulomata following orthopaedic operations support the concept that trauma plays a part in the evolution of these lesions.

Other types of tissue damage may be involved; thus granulomata have been reported following the implantation of minute quantities of talc on contaminated radium needles (Milstein, 1952).

The occasional occurrence of a long latent period remains an unexplained problem. Gruenfeld (1949) describes a massive granuloma measuring 12 x 5 cm. occurring in the abdominal wall ten years after an appendicectomy.

MATERIAL

The finding of four cases of talc granuloma amongst routine histological material in the Department of Pathology served as a stimulus to the production of this paper. The clinical histories of these cases are summarized in Table 1.

Macroscopic Description

The appearance of these lesions varies considerably. Some, on section, show a nodular surface. This nodular appearance led the earlier cases of talc granuloma to be mistaken for tuberculosis and hence the term "pseudo-tubercle" is frequently used to describe the lesion. In other cases much more fibrous tissue is present and in these it may be difficult to make out any pattern in the cut surface of the lesion.

Microscopic Description

The differences in amount of fibrous tissue are clearly seen. The granuloma is found to consist of masses of fibrous tissue in which many small nodules can be observed. In some cases the entire lesion is made up of these "pseudo-tubercles" (Fig. I). The edge of the lesion is ill-defined, strands of fibrous tissue radiating out into nearby structures (Fig. II).

On closer examination the "pseudo-tubercles" are seen to be an aggregation of giant cells, histiocytes and small round cells surrounded by fibrous tissue (Fig. III). Careful examination of the section, even without the use of polarized light, may show the presence of refractile material in the tissues (Fig. IV). If, however, polarized light is used, the prisms being at right angles, a "blacked out" field is obtained and the talc crystals light up brilliantly (Fig. V).

TABLE 1

SUMMARY OF THE CLINICAL FEATURES OF FOUR CASES OF TALC GRANULOMA

Case No.	Age	Sex	Original Condition and Procedure	Time Interval	Clinical Diagnosis
1 (K.H.)	38	Female	Carcinoma of cervix. Hysterectomy	3 months	Carcinomatous nodule in abdominal scar
2 (C.S.)	19	Male	Neurofibroma of forearm. Excision	6 months	Recurrent neurofibroma ? fibrosarcoma
3 (N.S.)	38	Male	Cyst in neck. Excision		Recurrence of cyst
4 (J.U.)	33	Male	Appendicitis Appendicectomy	6 years	

It can be seen that the usual error in diagnosis occurred. The nodule in each case was excised.

On using this method of investigation it can be seen that the situation of the talc crystals is irregular. In some cases most of the silicate is contained within the pseudo-tubercles; much of it actually contained in the foreign body giant cells (Figs. VI and VII). In some cases, however, most of the talc lies in the fibrous tissue outside the giant cell systems, little, if any, being within these systems (Fig. VIII). Even in those sections where talc crystals and giant cells are closely associated, crystals may still be evident in the fibrous tissue (Fig. IX).

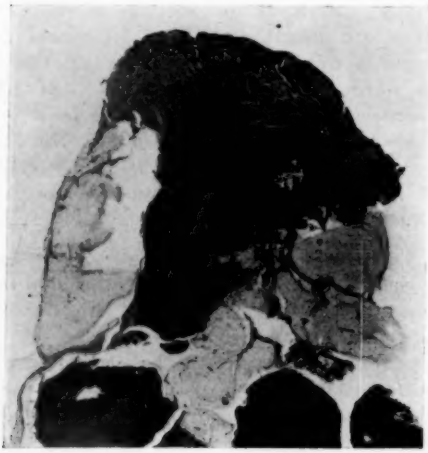

FIG. I. Photomicrograph of a section showing talc granuloma in subcutaneous tissue. The nodular structure of the granuloma can be seen (Case 1). (x 5)

EXPERIMENTAL WORK

In an attempt to show the effect of tissue damage on the formation of granuloma, the following experiments were carried out.

In each case the guinea pig was used as the experimental animal and the various procedures were performed under aseptic conditions.

A. The Lesion Produced by Talc Alone

Twelve experiments were performed. In 6 cases 1 c.mm. of dry sterile talc was implanted into the subcutaneous tissues of the inter-scapular region. In 6 others 1 c.mm. of a starch powder was introduced by the same route.

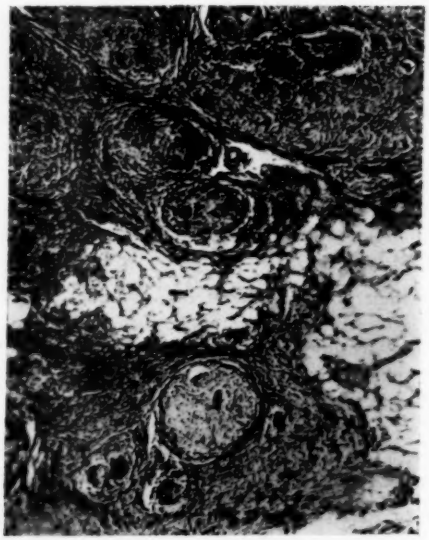

FIG. II. Photomicrograph of a section showing "pseudo-tuberculous" appearance of talc granuloma The ill-defined edge of the lesion can be clearly seen (Case 1). (x 50)

Both series healed by primary intention. Three weeks after implantation a biopsy was performed.

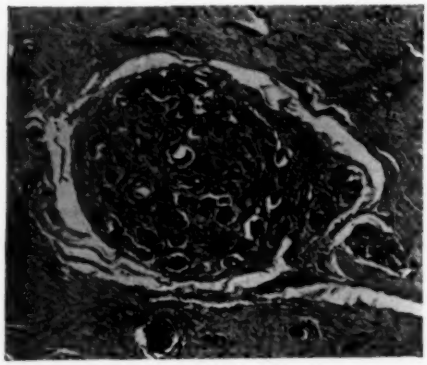

FIG. III. Photomicrograph of a section taken from a typical talc granuloma. A well-defined "pseudo-tubercle" is clearly seen (Case 3). (x 50)

On microscopy the wounds from the second group showed no deviation from the normal appearance of simple wounds of that age. The talc-contaminated wounds showed a well-developed collection of histiocytes and multiple foreign body giant cell formation. There was little fibrosis at

this stage, most of the introduced talc being found in the inflammatory tissue. It is to be observed that the wounds in both series were clinically indistinguishable, with no suggestion of nodule formation.

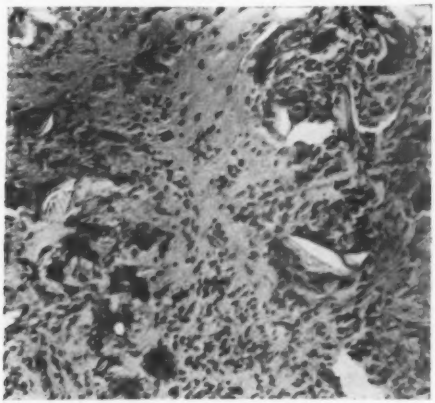

FIG. IV. Photomicrograph of a section showing refractile material in talc granuloma. Some of this material can be seen related to giant cells. Some is embedded in fibrous tissue (Case 1). (x 120)

After the elapse of three months, it was found that the talc-contaminated wounds had developed well-defined but minute subcutaneous nodules (about 5 mm. in diameter) situated at the site of talc introduction. Biopsy showed these to consist of typical talc granulomata.

FIG. V. Photomicrograph of the same section as Fig. IV taken with polarized light. Clearly shows doubly refractile talc crystals embedded in tissue. (x 120)

FIG. VI. Photomicrograph of a section taken with partially crossed Nicol prisms, showing nodule in greater detail. Numerous foreign body giant cells can be seen, some enclosing talc crystals (Case 3). (x 150)

FIG. VII. Photomicrograph of a section with partially crossed Nicol prisms showing the doubly refractile crystals and the character of the giant cells (Case 3). (x 350)

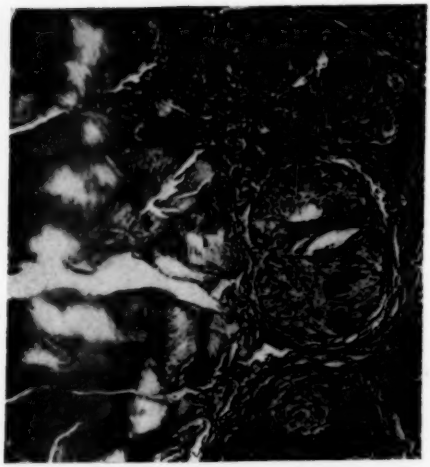

FIG. VIII. Composite photomicrograph of a section showing many talc crystals embedded in fibrous tissue beside giant cell systems. A photograph with crossed Nicol prisms is superimposed on an ordinary view of the section to show the relation of the refractile material to the tissues. Little, if any talc, is seen within the giant cell systems (Case 1). (x 50)

The development of such a granuloma after a lapse of three months is essentially the same result as had been produced by previous investigators (Fienberg, 1937; Lichtman, 1946, *et alii*).

B. Lesions Produced by Talc Plus Tissue Damage

In these experiments the tissues of the animal were subjected to preliminary damage by mechanical and chemical means immediately prior to the introduction of talc.

A control series of experiments was performed in which tissue damage alone was induced in the animal.

(i) Control Series

Two types of tissue damage were employed.

(a) Mechanical trauma induced by repeatedly crushing the subcutaneous tissues in toothed dissecting forceps. This method was used on eight occasions.

(b) Ether was poured into the wound and allowed to remain there for 30 seconds. It was then removed and the wound closed. This method was used on two occasions.

In all cases primary healing occurred, and the wounds, although showing some subcutaneous induration, showed no evidence of nodule formation over a period of six weeks.

Microscopic section of these wounds showed the changes of fat necrosis scattered in the tissues under the old incision.

FIG. IX. Photomicrograph of a section showing numerous talc crystals embedded in fibrous tissue. An occasional giant cell is also seen (Case 1). (x 150)

(ii) Talc Contaminated Series

Here seven animals were used. The preliminary tissue damage was produced in the following way:—

Mechanical trauma	2
Ether contamination	3
Absolute alcohol contamination	2

In all cases 1 c.mm. of dry talc was introduced into the wound which was then closed.

Again primary healing occurred. In all cases, however, gross induration was present in the subcutaneous tissues and, after the lapse of four weeks, nodule formation became evident. These nodules continued to increase slowly in size and when examined five to eight weeks after the introduction of

the talc their size ranged from 1 cm. to 2 cm. in diameter. The largest nodules were found in those animals whose tissues had been damaged by ether.

Histological section showed these nodules to have the characteristic appearance of talc granulomata (Fig. X).

FIG. X. Photomicrograph of a section showing experimental talc granuloma produced in guinea pig. Many talc crystals embedded in wandering cells are clearly seen. (x 200)

Thus, tissue damage produced either chemically or by trauma will increase the size of a talc granuloma and the rate at which it evolves.

DISCUSSION

The pathology of these lesions presents a number of interesting features. It has been established beyond doubt that talc contamination occurs much more frequently than do the lesions described above. The talc in these cases lies free in the tissue with no evidence of surrounding inflammatory changes. Even when a granuloma does occur much of the talc may lie outside the giant cell systems as has already been shown. The significance of this distribution is not clear. It may be that, perhaps associated with variable solubility of the crystals, only some part of the talc is producing tissue damage.

When minimal quantities of silicate are introduced, the production of a lesion may depend on several factors. Tissue damage is undoubtedly one of these. That damage may be produced by mechanical trauma, by irradiation or, as was done in the present experiments, by various toxic chemicals is easily demonstrable. The undesirable practice of bathing the tissues of the wound with alcohol solutions at the end of an operation could undoubtedly supply tissue damage of this nature.

The long latent period seen in some cases of talc granuloma lacks adequate explanation.

The idea of silica acting as antigen with delayed antibody formation (Gruenfeld, 1949) does not, as yet, have any demonstrable basis. Latent infection, which, for some reason, progresses after an interval and leads to subsequent tissue damage, may be a factor.

There is only one answer to the problem of talc contamination and that is obvious—never use talc as a glove powder when performing any surgical operation. It may be thought that washing of the gloves would afford adequate protection. This is not so. Even vigorous rubbing with water will not remove all the talc from the outside of gloves (Seelig, 1944).

Moreover, the probability of a glove puncture during the operation is high (70 per cent. of surgical gloves show puncture after being used for one operation [Weed and Groves, 1942]). The finger of a glove may contain 1-2 mg. of talc and this can be readily distributed in the wound.

SUMMARY

1. The dangers of using talc as a surgical glove powder when operating on any region of the body has been emphasized.

2. A short survey of the literature on this subject has been given.

3. Four cases of typical talc granuloma have been described.

4. The role of associated tissue damage in the evolution of these lesions is discussed and evidence that damage produced by mechanical trauma, ether and alcohol will increase the extent of a lesion has been produced.

5. Experimental introduction of starch powder into wounds has been shown to cause no interference with the usual healing of the wound.

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MALFORMATIONS OF THE ANUS

By F. Douglas Stephens

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THIS study follows on from the paper entitled "Congenital Imperforate Rectum, Recto-urethral, and Recto-vaginal Abnormalities" already published (Stephens, 1953). Emphasis in this paper is on abnormalities of the anus and associated anomalies of the genito-urinary tracts, but the two broad groups are compared and contrasted.

The term "imperforate anus" is frequently used to cover a wide range of congenital deformities of the anus and rectum. An attempt is made to group together and describe the regularly occurring abnormalities, and to provide them with an embryological explanation. A special study of the levels in the pelvis, of the abnormalities, and the pathological anatomy of the sphincters of each group provides a basis for the surgical technique used in the management of the deformities (Browne, 1951).

The visceral classification of Ladd and Gross (1947) into types 1 to 4 provides a simplified scheme on which to base treatment. In this paper, the associated skeletal abnormalities in addition to the visceral abnormalities are studied with a view to ensuring maximum use of the sphincter mechanisms available in the various malformations.

Levels of Abnormalities

The levels, in the newborn, to which the bowel descends in the more usual varieties of imperforate conditions of the rectum and anus, as judged from a study of post-mortem, radiological and surgical studies of cases in this series are:—

(1) To the pubo-coccygeal line. This is a line drawn from the upper surface of the pubis to the sacro-coccygeal junction (which, in the newborn, is the point immediately below the 5th or 6th ossified sacral vertebra). This is the approximate upper level of the *verumontanum*, the peritoneal pouch, the external *os* of the cervix, and Houston's third fold of the rectum.

(2) To the level of the lowest part of the ossified ischial bone as depicted in lateral X-ray views of pelvis. This is the level of the upper surface of the bulb of the urethra.

(3) To a site approximately 1.0 cm. caudal to the lowermost level of the ossified ischium. This is the level of the postero-inferior part of the *bulbo-cavernosus* muscle.

Wood Jones (1904) distinguished between imperforate anus and imperforate rectum.

The term imperforate rectum in this paper refers to the abnormalities which are caused by a lack in subdivision of the rectum from the cloaca, which then forms the common canal to the exterior of all three systems. The lumen of the rectum becomes narrowed ("recto-urethral" fistula) or sometimes obliterated at its point of junction with the upper end of the cloacal canal. In the male, this is the level of the pubo-coccygeal line (Fig. I). In the female the active epithelial proliferation and migration of the Müllerian ducts and vaginal bulbs, frequently incorporate the hindgut at its entry into the cloaca directing it towards the perineum as a fistula into the posterior wall of the vagina (recto-vaginal fistula) or *fossa navicularis* in the vestibule (recto-vestibular fistula) (Fig. II).

In this study, the anal group of anomalies applies to conditions where the rectum is completely subdivided from the urogenital sinus, but the anal pit is absent, rudimentary, or covered in by abnormal fusion of the genital folds, or is separated from the rectum by a partial or complete proctodaeal membrane. This group of anal deformities

occurs in relation to the upper and lower posterior levels of the *bulbo-cavernosus* muscles.

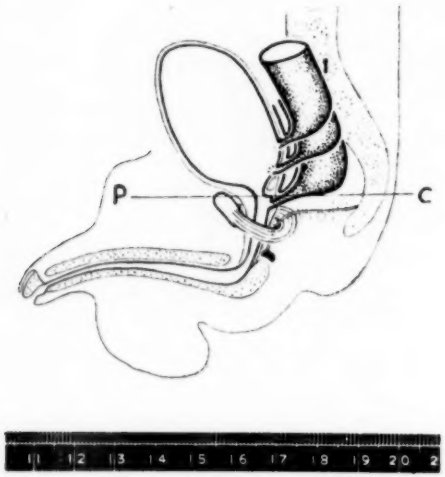

FIG. I a.

the allantois brought about by growth, rotation and folding processes in the hind end of the embryo. This indentation advances caudally as far as the level of Müller's hillock and the pubo-coccygeal line. The

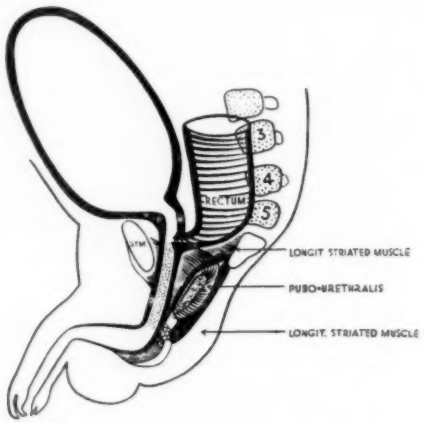

FIG. I b.

FIG. I. Imperforate rectum—male.
(a) showing the common imperforate rectum with or without fistula at the pubo-coccygeal line, and the rarer higher types.
(b) demonstrating the anatomy of the *levator ani* musculature lying between two sagittal bands of voluntary muscle, the upper forming the levator raphe, and the lower representing the rudimentary external sphincter. The segment of "urethra" marked with dots is that part rarely invaded by fistulae.

Rarely bizarre forms of local atresia of the rectum occur in much the same way as atresia of the bowel elsewhere. A string-like segment of variable length representing the atretic bowel connects the patent gut above with the lumen below. This rare type was not studied in detail in the paper.

EMBRYOLOGY

Imperforate rectum

In the previous paper (Stephens, 1953), a possible method of subdivision of the cloaca was suggested in an attempt to correlate the recurring imperforate rectum abnormalities with orthodox embryology. The following conclusions were put forward:—

(1) The endodermal cloaca is subdivided into the anterior uro-genital sinus and posterior rectum by two independent mechanisms; one indenting the cloaca from above at the site of junction of the hindgut with second mechanism occurs by lateral ingrowth carrying on the subdivision from Müller's hillock to the cloacal membrane, meeting in the midline from above down.

(2) The frequency of the recto-urethral fistula at the level of the *verumontanum* and the rarity of fistulae below this level are explained by the complete absence of the second mechanism. The cloaca remains undivided below this level, and narrows in calibre relative to the surrounding structures, at the same time constricting the hindgut communication.

(3) The female abnormalities are superimposed on the undivided cloaca by the arrival of the Müllerian tubes creating such conditions as imperforate rectum with cloacal fistula (Fig. IIIa), or recto-vaginal fistula and recto-vestibular fistula (Fig. II), when continued proliferation and migration of the Müllerian ducts and vaginal bulbs occurs.

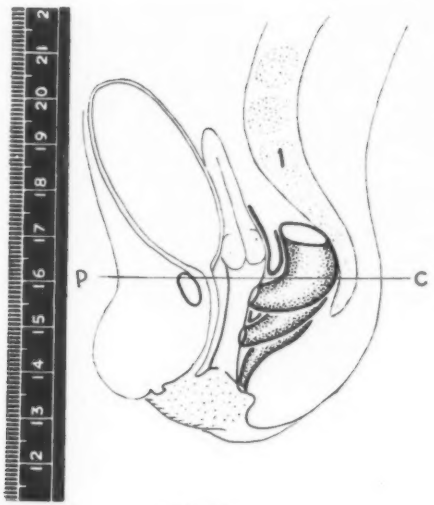

FIG. II a.

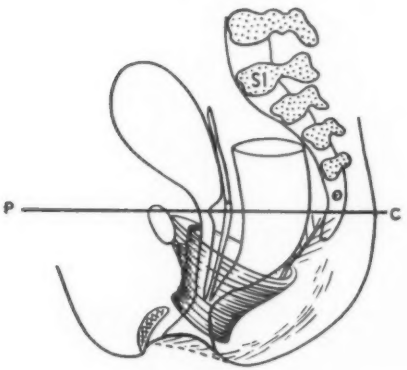

FIG. II b.

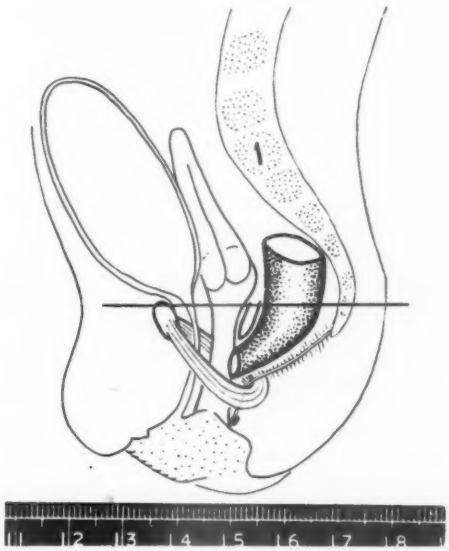

FIG. II c.

FIG. II. Imperforate rectum—female.
(a) showing the recto-vaginal fistula (upper two), and the recto-vestibular fistula, opening into the *fossa navicularis* of the vestibule.
(b) demonstrates the arrangement of voluntary muscle in a specimen of recto-vestibular fistula. The vagina was very atrophic.
(c) the relation of the levator sling of muscle to the recto-vaginal fistula is demonstrated.

level separates the Müllerian ducts almost entirely from one (Fig. IIIb) and these may or may not open into the bladder or fistula. The ureteric orifices in one specimen were normally situated and the fistula opened into the trigone. In another case only one ureteric orifice was situated normally and the fistula opened within the bounds of the trigone, but the second ureter and its vesical orifice had been completely sheared off and remained attached to the lateral wall of the left Müllerian tube. In the third case the ureters were entirely absent.

It is further presumed that the higher level imperforate rectum deformities result from failure of descent of the upper indentation, in addition to the failure of the lower lateral ingrowth processes. In the male, it is observed that the terminal rectum penetrates the bladder (Fig. I) at the site of entry of the Wolffian ducts maintaining practically regular relationship to the ureteric orifices. In the female, the presence of the rectal fistula at this higher

In only one case was there a well developed blind anus of apparently normal dimensions associated with an imperforate rectum.

Anal deformities

It is apparent from the study of the anal group deformities that the two most common sites for the termination of the rectum are at the upper and lower levels of the *bulbocavernosus* muscle of the urethra.

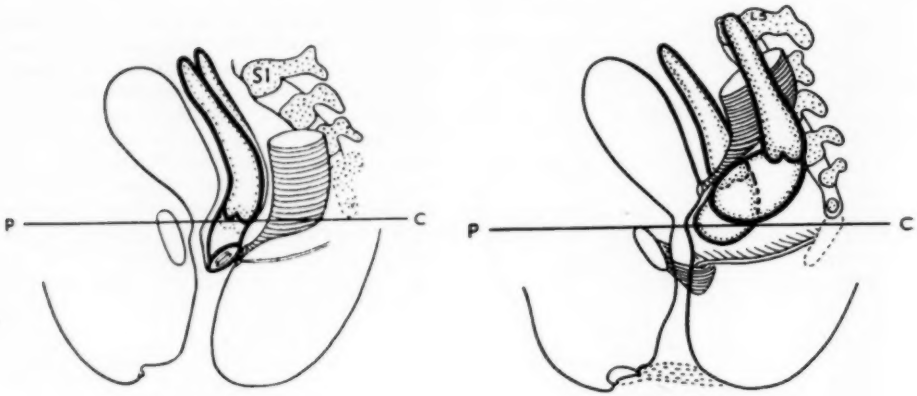

FIG. III a. FIG. III b.

FIG. III. Imperforate rectum—female—occurring at or above pubo-coccygeal line.
(a) at the pubo-coccygeal line—the short urethra, the septate short vagina and the rectum communicate with the common cloacal outlet.
(b) above the pubo-coccygeal line—the hindgut terminates in the base of the bladder and separates the two Müllerian tubes, which may penetrate or enter the lumen of the bladder.

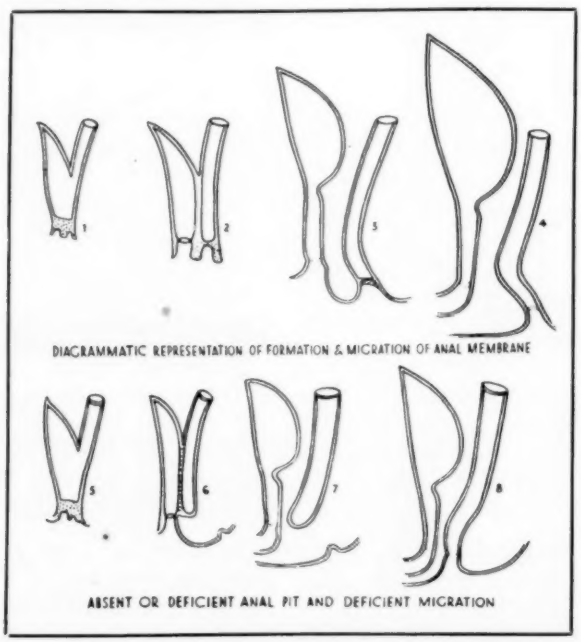

FIG. IV. (1-4) Demonstrates diagrammatically the normal formation and migration of the anal membrane, and the development of the perineum.
(5-7) Represents deficient formation of the anal pit with lagging in migration of the terminal end of the rectum from the original site of proximity to the urogenital membrane.
(8) Ectopic anus due to failure of development of the perineum and lack of migration of the otherwise normally developed anus.

At the 16 mm. stage embryo when the subdivision of the cloaca is complete, the uro-genital and anal pits lie closely approximated (Fig. IV). In the mature foetus, both in the male and female the anal pit lies considerably posterior to its original site. This migration occurs concurrently with the interposition of the perineum. In the male, the inner genital folds overlie the perineum by midline fusion beginning posteriorly at the anus and extending anteriorly to form the perineal raphe (Figs. I-IV).

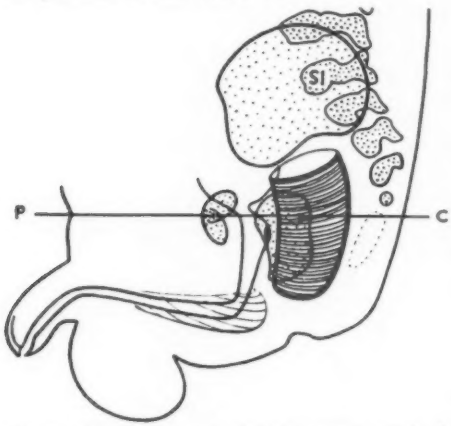

FIG. V. Imperforate anus showing common level of termination of rectum at the lower border of ischium, and junction of membranous and bulbous urethra.

It is the change in location of the anus which accounts for the two common levels of termination of the rectum in the male, one at the upper level of the *bulbo-cavernosus* muscle, and the other at the normal site of the valves of Morgagni at approximately the lower level of this muscle. The rectum ends at the upper level in cases of imperforate anus (Fig. V) where the anal pit is absent or grossly deficient, even though the rudimentary pit has migrated to its normal site (Fig. IV[7]).

In the case of the imperforate anal membrane the rectum lies at the lower level of the *bulbo-cavernosus* muscle (Fig. VI).

In the covered anus group, the perineum is lacking in varying degrees, and the inner genital folds fuse in the midline from the normal site of the anus forwards enclosing the anal pit and projecting it anteriorly. Wood Jones (1915) furnished a satisfactory embryological explanation for this deformity. In the case of the complete absence of the perineum, the anal fistula is projected into the bulb. In the partially developed perineum, the fistula is rolled anteriorly into some part of the perineal raphe even as far anteriorly as the *frenulum* (Fig. VII). The terminal end of the rectum ends at the upper surface of the bulb in the ano-bulbar fistula and along the line between this level and the normal level of the valves in the ano-cutaneous fistula. The genital folds rarely

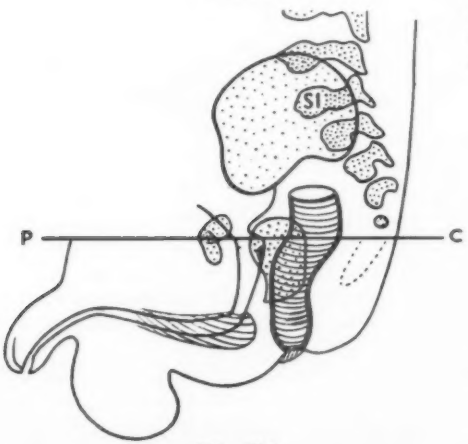

FIG. VI a.

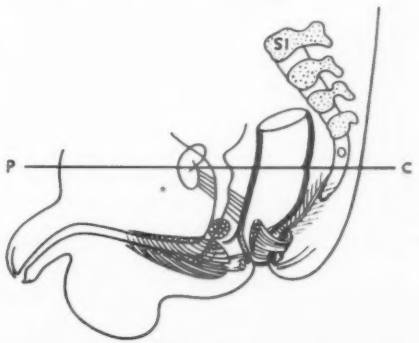

FIG. VI b.

FIG. VI. Imperforate anal membrane.
(a) demonstrating level in relation to lower margin of ossified ischium, and inferior aspect of *bulbo-cavernosus*. Cross hatching represents the perineal raphe across the membrane.
(b) indicates the *pubo-rectalis* muscle, and the deep division of the external sphincter at the level of the membrane.

meet in the midline in the female and the perineal raphe is usually absent. Occasionally the genital folds unite as in the male, but minor degrees of fusion, covering in the anus and projecting it forwards to the *fourchette* are more common (Fig VIIb).

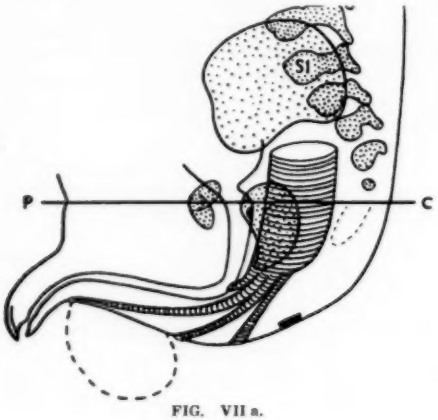

FIG. VII a.

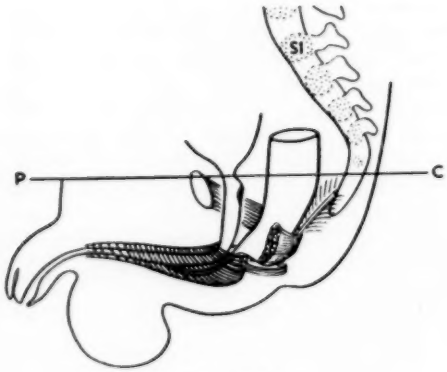

FIG. VII c.

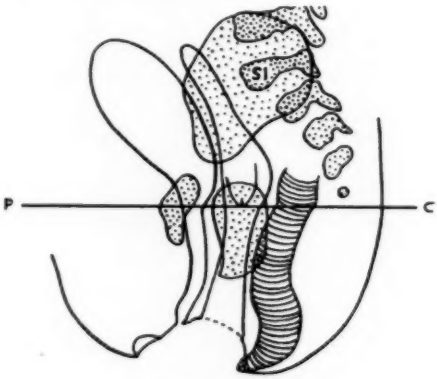

FIG. VII b.

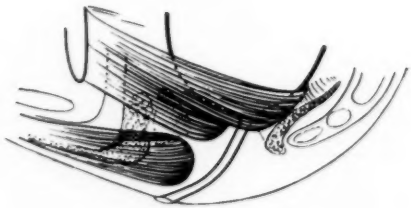

FIG. VII d.

FIG. VII. Covered anus.

(a) male:—ano-bulbar and ano-cutaneous fistulae.

(b) female:—ano-vulvar fistula—the narrow orifice of the fistula opens near the *fourchette*.

(c) the main voluntary sphincter muscles in a specimen of the ano-cutaneous fistula. Note absence of significant muscles below the neck of the fistula.

(d) voluntary muscle sphincters in a specimen of ano-bulbar fistula (post-operative reconstruction). The deep external sphincter bundle attaches anteriorly to the side of the *bulbo-cavernosus* muscle.

The ectopic anus is an otherwise normal anus which, due to failure of development of the perineum, has not migrated posteriorly to its usual site, and has been uninfluenced by the genital folds (Fig. IV[8]).

THE ANATOMICAL AND EMBRYOLOGICAL SUBDIVISIONS OF THE RECTUM AND ANAL CANAL

Anatomically the rectum commences at the level of the 3rd sacral vertebra, and extends distally to the apex of the prostate (Gray, 1938). The anal canal commences at the apex of the prostate or ano-rectal ring (Milligan and Morgan, 1934) and terminates at the orifice of the anus. The anal canal is that part which is surrounded by the sphincters.

Wood Jones (1911) divided the rectum and anal canal embryologically into three portions:—

(1) From an empirical site, namely, the 3rd sacral vertebra, to the lowest point

of reflexion of the peritoneum from its anterior surface, or Houston's third fold. This is the hindgut contribution.

(2) From this point to the anal valves. This is the post-allantoic gut segment of Wood Jones, or, according to the opposing theory, the cloacal contribution.

(3) From the anal valves to the external orifice, or that portion formed from the anal pit.

Whether the post-allantoic gut theory of Wood Jones is accepted or not, the studies made in this paper support these embryological subdivisions. Furthermore, the pubococcygeal line helps to subdivide the hindgut and cloacal segments in the newborn infant.

The upper and lower ends of the middle embryological segment of the rectum would be the levels at which the more common congenital anomalies may be expected to occur. The level of reflexion of the peritoneum or the pubo-coccygeal line is the upper level. The lower level of the middle segment lies originally between the urogenital and anal membranes, both of which become separated by the subsequent development of the perineum, the anal valves being transposed by the secondary development from close approximation to the urethra to the normal site. These sites in the infant male are presumed to be at the upper and lower levels of the *bulbo-cavernosus*. These levels in the female are disturbed by the invasion of the Müllerian ducts and vaginal bulbs.

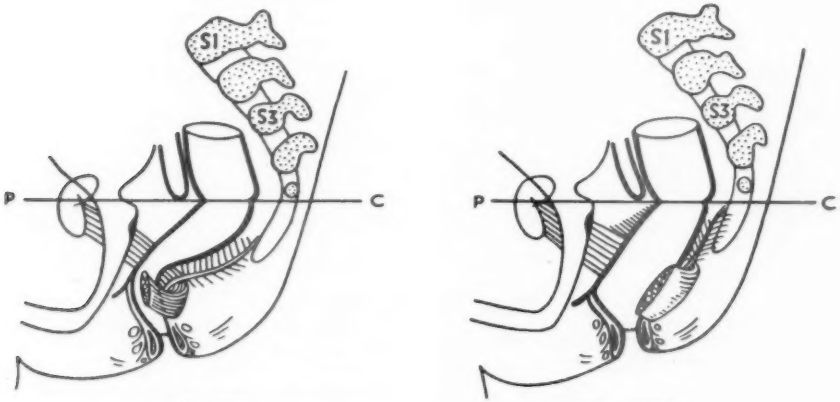

FIG. VIII a. FIG. VIII b.

FIG. VIII. Showing the anal canal.
(a) anatomical and surgical extending from the apex of prostate and the ano-rectal ring to the orifice of the anus, and surrounded by the sphincters including *pubo-rectalis* muscle.
(b) embryological anal canal extending from the level of the valves to the orifice of the anus, surrounded by the internal and external sphincters only, and demonstrable when *pubo-rectalis* is relaxed (e.g., under spinal anaesthesia).

The anatomical or surgical anal canal includes, therefore, both the lower portion of the cloacal and the whole of the anal contributions. On complete relaxation of the *pubo-rectalis* muscle, the upper half of the canal dilates to the calibre of the rectum above, exposing by contrast the structurally narrower anal segment below the valves of Morgagni (Fig. VIII). This is especially apparent in paralytic conditions of the anus such as spinal meningocoele and under spinal anaesthesia.

SPECIAL FEATURES OF THE ANAL GROUP OF ABNORMALITIES

Certain special features in the anal group are stressed:—

(1) Males predominate in this group, presumably because of those errors of formation which take place in the covering in of the perineum and bulbous and penile urethra by the genital folds.

(2) Blindly ending rectum is very rare in females, possibly due to the intrusion of

the active, almost cancer-like activity, of the epithelium in the terminal ends of the Müllerian ducts and vaginal bulbs, which presumably incorporate, transpose and enlarge the lumen of bowel or fistula (Wood Jones, 1904).

(3) All the anal anomalies which have a recognizable orifice to the exterior can be identified and classified without special investigation.

(4) X-rays are necessary to identify the level of the terminal end of the patent bowel in all blindly ending abnormalities, and in those with high "recto-urethral" anomalies in which the fistula is so narrow that gas cannot escape. The clue to the management lies in the accurate assessment by X-rays, or other means, of the level of the terminal end of patent bowel.

(5) The primary object of surgery, apart from saving life, is to construct an adequate anus with voluntary control. The actual position of the anus, be it in the vestibule, in a position immediately behind the vagina without a perineal skin bridge, or emerging caudal to the bulb of the urethra, if it is continent, is of little relative importance.

(6) In the anal group, the sacrum and coccyx are most frequently normal, assuring the presence of the *levator ani* and the nerve supply to the sphincters.

(7) A very careful search for a minute orifice in the male, along the line of the perineal raphe, or at the anal site in both sexes, must be made, with the aid of a magnifying glass if available, to exclude a fine fistula. A "fly speck" of meconium may direct attention to the orifice. Having located a fistula or orifice, the type of abnormality can be identified.

DESCRIPTION, INVESTIGATION AND TREATMENT OF ANAL ABNORMALITIES

(a) Imperforate anal membrane and anal stenosis (Fig. VI).

The external appearances may be normal. Attempts to introduce a finger or probe into the anus prove unsuccessful. On close inspection the central raphe may traverse the centre of the anus, and on straining the thin proctodaeal membrane may bulge and appear bluish, due to the colour of the meconium above it. Other cases, especially males, may have anterior or central tags of tissue or a hypertrophied central raphe, indicating the line of fusion of the genital folds across the membrane (the anal membrane should atrophy approximately at the 50 mm. stage and the genital folds begin to close in soon after). To the sides of the central raphe, fine dimples may be apparent. Sometimes these are patent, permitting the exit of a "fly speck" dot of meconium (Browne, 1951).

One specimen of imperforate anal membrane was available for dissection and microscopic examination by serial section (Fig. VIb). The inner circular and outer longitudinal smooth muscle coats ended abruptly at the level of the membrane. There was slight though indefinite thickening of the circular coat, and the longitudinal muscle ended in a fibro-muscular knot of tissue on the caudal aspect of the terminal end of the circular coat. The *pubo-rectalis* muscle bundle swept around the sides and posterior aspects of the membrane, tapering slightly in bulk as it approached the level of the membrane, and gaining intimate contact with the lowermost longitudinal fibres of the involuntary muscle coat.

The external voluntary sphincter was represented by a thin, deep, circular bundle on the level of the imperforate membrane, and by a poor attempt at formation of the middle sagittal segment which gained attachment to the coccyx and the *bulbo-cavernosus* muscle. The superficial external sphincter muscle could not be identified.

Inversion X-rays in the newborn period demonstrate the outline of the gas-filled rectum lying at the lower level, approximately 1.0 to 1.5 cms. caudal to the lowest ossified segment of the ischium.

Treatment is incision followed by digital dilation. The tags or central hypertrophied raphe may be excised in addition. For the anal stenosis, due to persistence of part of the membrane, dilation is sufficient, though skin tags can be excised if large.

It is important to differentiate this anomaly from the covered anus with small opening immediately anterior to the usual site. The posterior rim of such an orifice is tough tissue which can be more simply divided with scissors than dilated.

(b) Imperforate anus

This occurred almost exclusively in the male. The anal dimple may be absent or very rudimentary lying at its normal site (Fig. V).

To identify the completely blind ending anomalies of the anal and rectal groups additional assistance of X-rays, either using the Wangensteen-Rice inversion technique in the new born, or lipiodol technique in older infants, is required. The exact definition of the terminal bowel is particularly difficult and painstaking in the anal group, since besides being plugged with meconium, the lumen may be obscured in its terminal inch by contraction of the hammock-like sling of the *pubo-rectalis* which surrounds it. Several lateral views centring over the greater trochanter, and some taken at a distance of 6 feet to avoid projection distortions of the gas shadows and the ischial outlines of the bony pelvis, are usually required to catch the rectum in its distended state at a moment of relaxation of the *levator* musculature. These precautions, together with those mentioned in the previous paper (Stephens, 1953), are particularly necessary in the anal group of cases.

The level of termination of the rectum in this anomaly occurs at the upper border of the *bulbo-cavernosus*. This is recognized on the X-ray as the level of the lower border of the ossified ischial bone (Fig. V).

Aspiration of meconium with a wide bore needle may be indicated at the time of operation to confirm the level of the terminal end of the rectum. No actual specimen of this deformity was available for microscopic examination by serial section. From observations at operation it is presumed that the distribution of fibres of the *levator ani*, and the involuntary muscle coats are much the same as in the ano-bulbar fistulae (Fig. VIIc). But the histological structure of the external sphincter is even more conjectural.

The perineal approach to this anomaly is indicated, provided the approach is made immediately posterior to the *bulbo-cavernosus*, retracting backwards the sling-like fibres of the *levator* rather than cutting them. Because of the close attachment of the anterior wall of the rectum to the urethra, and the small size of the field of operation, mobilization is difficult. The canal heals by granulation tissue. For this reason prolonged dilatation is required in this type.

(c) Covered anus

(i) Males

The ano-cutaneous type of covered anus is recognized by the anterior location of the minute orifice sometimes surmounted by a "fly speck" of meconium situated in the line of the perineal raphe. Sometimes a very fine bluish line can be traced in the subcuticular tissue of the perineal raphe posterior to the orifice. This is the fistulous track shown up by its meconium content. The anal pit in the normal site is absent. The orifice may be sited immediately anterior to the normal position of the anus which is represented by a pit or is surmounted by enlarged fused genital folds or at any point between it and the frenulum. The scrotum is cleft in the more anterior group.

X-rays by the Wangensteen and Rice technique are not helpful as the gas escapes through the fistula giving misleading results.

A specimen of the ano-cutaneous fistula was examined microscopically by serial section (Fig. VIId). It was found that the inner, circular, smooth muscle coat terminated at the junction of the terminal dilated rectum with the neck of the narrow fistula. The outer longitudinal coat petered out a few millimetres along the track, and posteriorly split up into septa which divided the lower components of the *pubo-rectalis* into the bundles.

The *pubo-rectalis* was the main muscle which could be identified both macroscopically and microscopically as a strong sphincter sling intimately related to the rounded lower end of the rectum and the first 0.5 cm. of the length of the fistula (Fig. VIId). The main mass of the sling-like fibres swept forwards and upwards to

its origin at the pubis. Some fibres appeared to gain attachment to the fibro-muscular perineal body.

The external sphincter was represented by a thin collection of longitudinal fibres passing in a sagittal plane on either side of the fistula from the coccyx to the *bulbo-cavernosus*. Around the neck of the fistula some fibres appeared to form a circular sphincteric ring but it was not possible to distinguish this group of fibres from the lowermost fibres of the *pubo-rectalis* muscle.

It was apparent that no important sphincteric fibres were present along the whole course of the fistula apart from those already described around its neck.

The Denis Browne technique of laying open the fistula by a simple cut-back incision of the caudal wall of the fistula with scissors in the line of the perineal raphe, posterior to the orifice, was the most simple and successful method of treatment. A cut is made sufficiently far back to permit the introduction of size 18 urethral sounds. No attempt at suturing is required but increasing sized dilators are used for a few weeks until the fifth finger tip can be introduced. Thereafter the parent dilates the anus daily until the passage is healed and shows no tendency to stenosis.

The end result of this procedure is a somewhat untidy though continent anus. Absence of the superficial external sphincter enables the lower margin of rectal mucosa to be inspected by gently parting the buttocks. Anal stenosis following this procedure is rare.

Ano-bulbar fistula

The perineum and normal site of the anus is transversed by a sagittal, usually hypertrophied, central raphe. The scrotum is cleft and the penis, in 4 of the 5 cases, showed an atypical type of hypospadias with chordee and a posterior orifice slightly anterior to the bulb of the urethra, through which urine, much meconium and mucus were passed. The urethral lumen anterior to this orifice was partially reformed.

One post-operative specimen of ano-bulbar fistula was available for microscopic examination by serial section. There was, in this child, a slight degree of chordee but no hypospadias opening. At operation a perineal anal orifice was made by incising the skin over a urethral sound which was passed per urethra along the fistula and everted in the perineum close to the posterior margin of the bulb. The rectal mucosa on the posterior margin had been sewn down to the skin. Fig. VIIc shows the presumed preoperative distribution of the sphincters in this deformity. The site of entry of the fistula into the bulb, in this case, was immediately distal to the termination of the ducts of Cowper's glands.

The *levator ani* musculature encircles the lower end of the rectum in the usual fashion to approximately the level of the beginning of the ano-bulbar fistula. The involuntary circular and longitudinal coats form a knot of convoluted muscle at the site of emergence of the fistula from the terminal end of the rectum. Below the terminal rectum and in close approximation with the *bulbo-cavernosus* is a moderately thick bundle of muscle which, in this specimen, has the appearance of a sling of muscle arranged parallel with the *pubo-rectalis* but separated from it by a band of connective tissue and gaining attachment to the lateral sides of the *bulbo-cavernosus*. It is considered that this muscle represents at least the deep portion of the external sphincter. In addition there are a few isolated voluntary fibres passing in the subcutaneous tissues in a sagittal direction from the coccyx to the bulb.

In three cases with combined atypical hypospadias deformity, Denis Browne cut back the urethra, perineal raphe and fistula, in the midline as far as the posterior end of the bulb, exposing both the orifices of the posterior urethra and rectum. The anus was dilated and dressed with vaseline gauze until the area had healed. It was found that in all three cases the children were continent of faeces and urine. At a later date, the urethra in all cases was repaired by the Browne (1949) method for hypospadias.

(ii) Females

Ano-vulvar fistula

The anus and anal dimple are absent and often the site of the anus is filled in by a central sagittal fold suggestive of a hypertrophied perineal raphe. The lumen of the

anus is projected anteriorly to open at or close to the *fourchette* or posterior vulval margin (Fig. VIIb).

The orifice is constricted and causes partial obstruction, though stools the consistence of meconium are passed with ease. Once the motions become firmer, the infant has difficulty in evacuation, the stools being expressed with great effort as toothpaste like ribands. The vagina and vulva anterior to this fistula are otherwise normal.

This deformity must be recognized from the recto-vestibular fistula already described (Stephens, 1953). The probe, when introduced into the ano-vulvar fistula, can be passed backwards under the perineal skin, whereas in the recto-vestibular fistula the probe passes cranially and only with forceful depression can it be felt through the perineum.

No actual case of this deformity is available for microscopic examination.

The cut back technique is used for this deformity also. The incision is made large enough to introduce a size 20 urethral sound. Gradually larger sounds are passed until the anus is healed. Thereafter for several weeks, the parent dilates the anus several times a week with the 5th finger.

Continence is excellent. The anus is separated from the vagina only by a mucosal bridge and on rectal examination with the finger, the strong sling-like band of *pubo-rectalis* is palpable. No anterior band can be felt, and one wonders whether continence is obtained entirely by *pubo-rectalis* and the internal sphincter muscles, or whether a small contribution is made by deep fibres of an external sphincter in addition.

Attempts at actual transplantation of the fistula to a more posterior position in the perineum in order to create a skin bridge between vagina and rectum frequently fail. The new orifice has a strong tendency to stenose, and the old fistula often re-opens so that the faecal stream is split, some passing forward to soil the vulva, and some overflowing backwards through the stenosed artificial anus. Cutting the skin bridge between the two orifices usually cures the incontinence and the stenosis in these cases.

PRINCIPLES IN TREATMENT

Certain factors must be considered before surgery is instituted—

(1) The type of deformity must be decided by all available means of investigation, and where necessary the level to which the terminal pervious bowel descends in the pelvis.

In the blindly ending conditions of the rectum and in the fine fistula conditions in the imperforate rectum of the male, the level can usually be detected by X-rays. The visible fistulae in the males and the vulval, vestibular, vaginal and cloacal fistulae in the females can usually be diagnosed by inspection and probing under anaesthesia. The ano-bulbar type may be accompanied by the atypical hypospadias, though if not, the passage of a sound into the rectum through the urethra and fistula will confirm the diagnosis.

The higher level imperforate rectum deformities with or without recto-vesical fistulae are the most difficult. The location of the terminal bowel may be in doubt on X-ray and resort to cystoscopy, laparotomy and transverse colostomy with further lipiodol investigation may be indicated.

(2) All those anomalies in which the terminal end of the normal calibre rectum descends to or below the upper surface of the *bulbo-cavernosus* or the lower margin of the ossified ischium as determined on adequate X-rays may be appropriately dealt with through the perineal approach.

Those which lie between the level of the lower ischial border and the pubo-coccygeal line can be operated on by the sacro-coccygeal technique. The higher level imperforate rectum deformities require abdominal mobilization combined with the sacro-coccygeal technique. In the female, the dilated and separated Müllerian ducts are very much enlarged and though none have come to operation in this series, it is apparent that they would make for additional difficulties.

(3) The anal operations from the perineum can be performed as a primary measure. The sacro-coccygeal and the combined

abdominal and sacro-coccygeal techniques should be preceded by a colostomy, so sited as to leave the sigmoid loop free for subsequent mobilization. The second stage should probably be delayed for a year or more to permit greater ease of manipulation through the sacro-coccygeal exposure.

COMPARISON OF ANAL AND RECTAL GROUPS

Numbers of cases

Thirty cases of imperforate rectum group were collected and studied over a period of five years. In the same time many more cases of the anal group were seen and treated but only 28 are available for this analysis. Table 1 shows the various types of abnormality included in this series and the numbers in each group.

Sex incidence

In the imperforate rectum group, the sex distribution is even, there being 16 males and 14 females. The males predominate in the anal group, though a number of the ano-vulvar type were seen and not recorded.

In this series, the blindly ending rectum is limited almost entirely to males.

Mortality

There were 15 deaths in the total of 30 cases of imperforate rectum. Ten of these were directly due to accompanying abnormalities, but five could be attributed to complications arising from surgical procedures of varying nature. In the anal group, there were 6 deaths in 28 cases, of which 4

TABLE 1

ANAL DEFORMITIES	
Imperforate anus (Fig. V)	5
Imperforate anal membrane (Fig. VIa)	1
Anal membrane stricture (includes 1 female)	7
Covered anus (Fig. VIIa)	
ano-cutaneous fistula	6
ano-bulbar fistula	5
ano-vulvar fistula (females) (Fig. VIIb)	3
Ectopic anus (female)	1
Total	28

IMPERFORATE RECTUM DEFORMITIES	
Male	
Imperforate rectum at level of pubo-coccygeal line (Fig. I)	6
" " with "recto-urethral" fistula at pubo-coccygeal line	7
" " with or without fistula at higher level in urinary tract	3
Female	
Imperforate rectum with cloacal fistula—septate vagina (Fig. IIIa) (corresponding to imperforate rectum with "recto-urethral" fistula in the male)	4
" " with recto-vaginal (2) and recto-vestibular (5) fistulae (Fig. II) (corresponding to recto-urethral fistula in the male but with subsequent development and migration of the Müllerian ducts and vaginal bulbs)	7
" " at higher level with recto-vesical fistula (Müllerian ducts completely separate with hindgut intervening) (Fig. IIIb)	3
Total	30

could be reasonably attributed to accompanying abnormalities but two were post-operative. It is not known how many of the remaining children have progressed during the past three years, as this information is not now available to the author. It appears from these observations, that the accompanying abnormalities in the anal group are more compatible with life, at least in infancy.

Spinal abnormalities

It is well recognized that other abnormalities frequently coexist with anal and rectal malformations (Ladd and Gross, 1947; Moore and Lawrence, 1952). In this series the accompanying abnormalities are compared in the anal and rectal groups.

and coccygeal abnormalities are to be expected more commonly in the rectal than the anal group (Table 2).

Accompanying genito-urinary abnormalities

In both groups, the numbers of cases in which the genito-urinary tracts were not investigated was high (Table 2). In the rectal group 15 came to necropsy, and 9 of these had dilated ureters. In the female imperforate rectum with cloacal fistula at the approximate level of the pubo-coccygeal line, the uterus was bicornuate and the short vaginae were fused, though septate. In the 3 female specimens in which the rectum opened into the posterior wall of the bladder, the Müllerian ducts with their uterine and short vaginal segments were entirely separate.

TABLE 2

ACCOMPANYING ABNORMALITIES

	Sacrum and Coccyx			Genito-urinary			Other abnormalities	
	Abnormal	Normal	Not known	Abnormal	Normal	Not known	Abnormal	Not known
Imperforate rectum 30 cases	17	10	3	13	3	14	8**	22
Anal abnormalities 28 cases	2	19	7	9*	2	17	7	21

* 4 of these had hypospadias deformity, associated with ano-bulbar fistula

** 2 cases had tracheo-oesophageal fistulae and 1 case had a hare lip

It was found that deficiencies and abnormalities of the sacrum and coccyx occurred in at least 17 of the 30 imperforate rectum cases. These ranged from total absence below the first sacral to hemi-vertebrae or recurved sacrum. In two older cases of absence of sacral vertebra below the first vertebra, there was incontinence of urine as an additional complication. In one such newborn infant, who died soon after birth, the *levator ani* was represented by a pale membrane which resembled fascia but which, on microscopic examination, was seen to contain a very thin layer of voluntary muscle fibres.

In at least 19 out of the 28 cases of the anal group, the sacrum and coccyx were normal, and in four of the 19 cases, there were six sacral segments. Presumably sacral

Both in the males and females, the mortality due to associated genito-urinary abnormalities, was 100 per cent. in those cases where the terminal rectum was attached to or opened into the bladder above the pubo-coccygeal line.

Of the 28 cases of the anal group only 6 died, and of these one had a horse-shoe kidney, one had enlarged ureters, one bilateral hydronephrosis and one a glandular hypospadias. Of the remaining necropsy cases, one was otherwise normal and results of one are not known by the author. Five other living children have genito-urinary anomalies, but of these four were atypical hypospadias conditions, intimately combined with the ano-bulbar fistulae, and the fifth was a septate vagina in the case of an

ectopic anus. Two of the remainder were definitely normal, but 17 were not investigated fully to determine the state of the urinary tract.

The most severe deformities in the urinary tract occur in the imperforate rectum group, and this is explained by the early nature of the malformation. At this embryonic age the development of the ureters, renal blastema, cloacal subdivision processes, and rotation of the hind end occur concurrently, a factor conducive to allied severe urinary and spinal abnormalities. The anal group abnormalities occur after these processes are concluded and are therefore less liable to serious urinary or spinal implication.

The appearance and development of the Müllerian ducts in the female complicates the preformed deformities of the cloaca and anus. Those terminating at the pubo-coccygeal line are septate and short. Those ending above this line are short, separate and usually dilated. Those ending below are usually normal apart from the fistulous opening of the rectum into its posterior wall.

Other abnormalities

Approximately 25 per cent. of both groups were found to have other abnormalities (Table 2). The 2 cases of associated tracheo-oesophageal fistulae and the one case of associated hare lip, support the belief that the abnormal development in imperforate rectum deformities occur at the time of subdivision of the cloaca—that is, between the 4-16 mm. stages. No help can be obtained from the diverse anomalies of the anal group.

ASSESSMENT OF RESULTS

The few cases subjected to operation by the sacro-coccygeal approach are insufficient to draw significant conclusions. One recto-vaginal fistula case treated by this method, in whom the sacrum and coccyx were normal, now has satisfactory continence and attends school regularly without soiling.

In the anal group, the imperforate anus in the male is liable to stricture formation necessitating more prolonged dilatation. Once the new anal canal becomes supple, continence can be expected. The remainder in this group develop continence soon after operation unless there is any accompanying severe sacral deformity.

It is important to remember that symptomatic dilatation of the rectum and megacolon develops quickly proximal to a congenital stricture of rectum or anus, and will occur even though soft bowel content is evacuated through the narrow orifice in the early stages. Having overcome the stricture, by appropriate and adequate surgery, bowel actions commence normally, but the dilatation persists for a much longer period. So long as the dilatation persists, the motions when formed will remain large in calibre. If unduly hard, these large motions cause discomfort, and the infant will begin to hold back its motions, causing faecal accumulations in the rectum and colon. Eventually, a continuous overflow occurs which closely resembles the incontinence due to sphincter deficiency. The treatment for this condition is similar to that of idiopathic megacolon described by Bodian *et alii* (1949), the essence of which is total evacuation by bowel washouts (not enemata) 3 times a week for three weeks, twice a week for two weeks and once per week for several weeks, bowel training and the use of bowel stimulants until the habits are regular. The importance of this condition is emphasized in assessing the results of surgery, lest a hopeless attitude be adopted, and permanent colostomy be advised prematurely.

SUMMARY AND CONCLUSIONS

(1) The three levels in the pelvis in the newborn male at which the common congenital abnormalities of the rectum and anus occur are the pubo-coccygeal line, the lower border of the ossified ischium and a site approximately 1.0 to 1.5 cms. caudal to the ischium.

(2) In the male the visceral levels corresponding to these skeletal sites are the bladder neck, the upper surface and the lower and posterior aspect of the *bulbo-cavernosus*.

(3) In the female, the intrusion of the Müllerian ducts and vaginal bulbs causes a group of abnormalities which bear no constant relation to the middle level of the male.

(4) Embryologically in the male the siting of the common abnormalities corresponds to the upper and lower ends of the endodermal cloaca. After subdivision of the cloaca, the anal membrane

TABLE 3

DETAILS OF ACCOMPANYING ABNORMALITIES

(i) Imperforate Rectum Group — (30 cases)

Type	No.	Sex	P.M.	Cause of death	Sacrum and Coccyx	Genito-urinary anomalies	Other anomalies
Imperforate rectum at P/C. line	6	M	1	post-operative	5 abnormal ranging from sacral deficiency below S1 to hemi-vertebra, 1 normal	1 hydro-ureters and 4 not known, 1 normal	6 not known
Imperforate rectum at P/C. line with cloacal fistula	4	F	2	1 not known 1 peritonitis	2 gross deficiency in sacrum; 1 hemi-vertebra; 1 recurved sacrum	2 short double vagina; 2 not known	4 not known
Imperforate rectum with recto-urethral fistula at P/C. line	7	M	4	2 died tracheo-oesophageal fistulae; 2 died post-operative complications	1 lower sacrum and coccyx absent; 1 spina bifida; 4 normal; 1 not known	1 aplasia R. kidney and hydro-ureters; 1 transposed R. kidney; 1 normal; 4 not known	2 tracheo-oesophageal fistulae; 1 hare lip and cleft palate; 4 not known
Imperforate rectum with recto-vaginal fistula	2	F	1	1 anaesthetic death	1 normal; 1 not known	1 normal; 1 not known	1 left inguinal hernia 1 cardiac abnormality
Imperforate rectum with recto-vestibular fistula	5	F	1	1 died associated urinary anomaly	1 S4 and 5 deficient 1 S5 deficient 3 normal	1 absent R. kidney and L. hydro-ureter 1 atrophic vagina 3 not investigated	5 not known
Imperforate rectum with (or without) fistula at higher level	3	M	3	3 died from complicating genito-urinary anomalies plus other anomalies	1 sacrum deficient below S1; 1 sacrum deficient below S3; 1 sacrum deficient below S4	all had hydro-ureters, kidney abnormalities, intra-abdominal testes	1 non-fixation of abdominal mesentry; 1 pulmonary atelectasis; diaphragmatic hernia agenesis right lung, coarctation of aorta, exomphalos, talipes equino-varus. 1 pulmonary atelectasis
Imperforate rectum with recto-vesical fistula	3	F	3	3 died from complicating genito-urinary anomalies	1 hemi-vertebra in sacrum and contracted pelvic outlet. 1 normal 1 not known	all had dilated separate lower Mullerian ducts 2 had hydro-ureters, 1 absent ureters and kidneys	1 nil 1 was uniovula twin of opposite sex; 1 not known

(ii) Malformations of the anus — (28 cases)

Type	No.	Sex	P.M.	Cause of death	Spine	Genito-urinary anomalies	Other anomalies
Imperforate anus	5	M	2	2 post-operative	1 S5 absent 3 normal 1 not known	1 glandular hypospadias 4 not known	1 cardiac ventricular septum anomaly; 4 not known
Imperforate anal membrane and anal stenosis	8	7M 1F	1	1 genito-urinary anomalies and post-operative complication	1 S4 absent 1 with 6 sacral segments 5 normal 1 not known	1 atresia right ureter and absence of right kidney; 7 not investigated	1 talipes equino-varus 7 not known
Covered anus group (a) Ano-cutaneous fistula	6	M	2	1 urinary anomaly 1 unrelieved obstruction, Mongol	2, 6 sacral segments; 2 normal 2 not known	1 bilateral hydro-ureters 2 nil 3 not investigated	1 Mongol 1 mentally retarded; 4 not known
(b) Ano-bulbar fistula	5	M	1	1 pulmonary haemorrhage	1, 6 sacral segments; 3 normal 1 not known	4 combined atypical hypospadias 1 horse-shoe kidney	1 pulmonary atelectasis 1 hemi-vertebra in lumbar spine; 3 not known
(c) Ano-vulvar fistula	3	F	0		2 normal; 1 not known	3 not investigated	1 dwarf 2 not known
Ectopic anus	1	F	0		not known	double vagina	1 not known

migrates caudally and posteriorly to the final site of the anal valves, which is the third and lowest embryological level.

(5) The anal group of anomalies consists of the following types—

(i) imperforate anal membrane and stenosis, (ii) imperforate anus, and (iii) the covered anus group. The imperforate anal membrane occurs at the level of the anal valves and is the lowest level deformity. Imperforate anus is that deformity in which the cloaca is completely subdivided, but the anal pit is absent or rudimentary, and the rectum ends at the second level. The covered anus group occurs most frequently in the male and is due to abnormalities associated with excessive fusion of the genital folds which normally close in the uro-genital sinus in the male. Less frequently this fusion occurs in the female, closing in the anal pit and projecting the lumen anteriorly towards the *fourchette*.

(6) In rectal and anal deformities in which the sacrum and coccyx are normal, the *levator ani* musculature is well represented. The external sphincter in the imperforate rectum group was represented by only a sagittally arranged band of voluntary muscle fibres passing from the bulb to the coccyx. In the anal group, excluding the imperforate anus, of which no specimen was available for section, the external sphincter was represented by only a thin, circular, deep band of voluntary muscle gaining attachment to the *bulbo-cavernosus* anteriorly, and a thin collection of sagittally arranged fibres passing from the coccyx anteriorly in the direction of the *bulbo-cavernosus*.

(7) All those abnormalities lying at or below the lower border of the ischium may be treated surgically as a primary measure through the perineal approach. Treatment of the higher level deformities, including recto-vaginal fistula, should be preceded by a colostomy. For those in which the terminal rectum extends to the level of the pubo-coccygeal line, the sacro-coccygeal technique is advised. Higher level deformities require preliminary abdominal mobilization combined with the sacro-coccygeal approach.

(8) The imperforate rectum deformities are more frequently accompanied by severe sacral and genito-urinary deformities, which were the cause of death in those cases in which the rectum terminated higher in the pelvis than the pubo-coccygeal line.

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THE MECHANISM OF CIRCUMFLEX AND OTHER NERVE INJURIES IN DISLOCATION OF THE SHOULDER, AND THE POSSIBLE MECHANISM OF NERVE INJURIES DURING REDUCTION OF DISLOCATION

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THE circumflex (axillary) nerve is the most frequent nerve to be damaged in dislocation of the shoulder. There is, however, a difference of opinion among authors regarding the frequency of circumflex palsy in shoulder dislocations.

Watson-Jones (1952) writes that the circumflex nerve is damaged in more than 5 per cent. of dislocated shoulders. De Palma (1951) found a circumflex palsy in 25 per cent. of dislocations. Murray (1938) gives the highest estimate when he states that between 55 and 60 per cent. of dislocations of the shoulder can be shown to have a circumflex nerve lesion. Murray also points out that the nerve injury may take place during reduction, especially if this has been violent.

Various mechanisms have been suggested that would produce a circumflex nerve lesion during dislocation of the shoulder. McGregor (1943) postulated that the nerve was crushed between the head of the humerus and the thick axillary border of the scapula. Most authors, however, believe that the lesion is produced by traction. It is likely to be a traction injury because of the usual rapid recovery and the fact that the motor palsy may be nearly complete, while the sensory loss is variable (Seddon, 1947). J. H. Stevens (1934) was the first to give a detailed account of the possible mechanism. He states that the nerve is stretched across the head of the humerus when the arm is abducted and externally rotated during dislocation.

The purpose of this investigation was to study the possible mechanisms by which circumflex palsy can be produced during dislocation and reduction of the shoulder; and also to study the tension produced on other branches of the brachial plexus during the same manipulations.

Method and Results

Fifteen recent cadavers were studied. *Pectoralis major* and *minor* were divided near their insertions and reflected to show the contents of the axilla. A short segment of the axillary vein was removed and the main branches of the brachial plexus were sufficiently cleared of surrounding tissue to enable them to be identified. Although it would have been desirable to measure accurately the tension in the axillary nerves, it was thought that any apparatus to do this would interfere with the anatomy of the region to such an extent that the results could not be applied to clinical practice.

When the arm is in the anatomical position all the axillary nerves are found to be lax. With the arm by the side of the body strong downward traction was applied to the hand. The traction was maintained and the tension on the nerves compared by palpation to the tension without traction. Maintaining the traction, the shoulder was fully internally rotated and then fully externally rotated and the tension of the nerves again compared. The shoulder was next abducted to a right angle and traction exerted laterally. The tension on the nerves was again compared in full rotation, first internal and then external. Finally, the arm was hyperabducted and traction applied in this position. Internal rotation is very limited in full abduction to the tuberosities of the humerus impacting against the acromion; however, the tension on the nerves was compared within the range of rotation that is permitted. In all cases the standard for

comparison was the tension on the nerves with the arm in the anatomical position before traction was applied.

The results are given fully in Table 1.

nerve. But all the main branches of the brachial plexus passing into the arm were pulled upon proportionately to the strength of the traction. Full internal rotation in some cases greatly increased the traction on

TABLE 1

SHOULDER NOT DISLOCATED

		Traction with arm by side	Traction at right angle to body coronal plane	Hyper-abducted arm, coronal plane
Circumflex nerve	External rotation	0	0 - 1	0
	Internal rotation	0 - 1	0 - 1	0 - 1
Radial nerve	External rotation	0 - 1	1	0
	Internal rotation	1	1 - 3	0 - 1
Ulna nerve	External rotation	0	1	0
	Internal rotation	0	1	0
Median nerve	External rotation	0	1	0
	Internal rotation	0	1	0
Musculo-cutaneous nerve	External rotation	0	1 - 2	0 - 1
	Internal rotation	0	1	0

Legend 0 : Nerve lax, with definite slack.
1 : Moderately taut, with no slack.
2 : Taut, with some side to side movement possible.
3 : Stretched tight, little if any lateral movement possible.

Downward traction with the arm by the side produced little pull on any of the nerves of the brachial plexus. A combination of traction and internal rotation resulted in a slight pull on the circumflex and radial nerves.

In some cases traction and external rotation also caused a slight increase in tension on the radial nerve.

When the pull was applied to the arm at right angles to the body in a coronal plane, there was little traction on the circumflex

the radial nerve (or posterior cord) and full external rotation increased the pull on the musculo-cutaneous nerve.

In the hyper-abducted position, rather surprisingly, there was not any great pull on the plexus.

In all cases the shoulder was dislocated by hyper-abduction and external rotation following the mechanism first described by Codman (1934). In some cases it was necessary to partially divide the inferior capsule of the joint; in others the capsule tore and the dislocation was easily produced.

Fig. I. is a photograph of the axillary region in this stage of the dislocation.

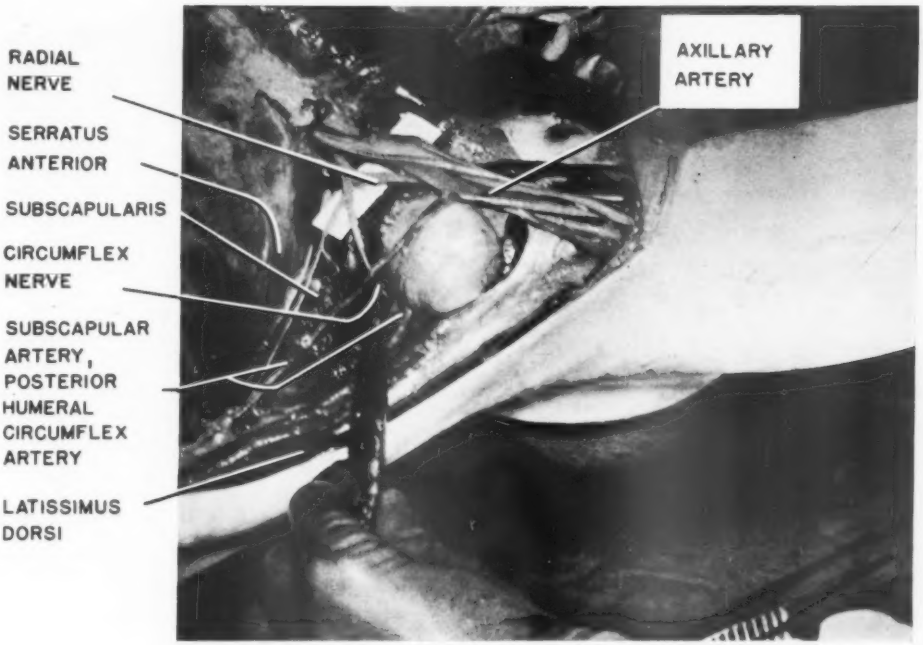

FIG. I.

The arm was then brought to the side and internally rotated so that the hand lay across the body. When examined, the shoulder appeared similar in every way to a dislocated shoulder as seen in a casualty department. The hollow below the acromion, the humeral head beneath the coracoid, internal rotation and the slightly abducted shaft, were all present.

When the dislocation was done slowly certain features of interest were noted.

1. The circumflex nerve was under greatest tension when it was stretched across the head of the humerus during the hyperabduction stage of dislocation.

   In one case the nerve ruptured one inch from its origin at the posterior cord.

   In some cases the nerve remained below the head and in the normal relationship to the neck of the scapula (as shown in Fig. I). In others, the nerve remained close to the surgical neck of the humerus (Fig. II). In either event, the nerve was taut during dislocation. But the relationship is more important in considering the risk of circumflex injury when reducing a dislocated shoulder (see below).

2. As the head of the humerus is pressed downwards it lies against the tense tendon of the long head of triceps. When the arm is medially rotated the head slips anteriorly across this tight band and the anterior subcoracoid position is produced. Thus, the common anterior position of the head can be brought about by medial rotation hooking the head of the humerus across the front of the long head of triceps.

3. The axillary artery is considerably distorted by the fixed subscapular artery (Fig. I). In this case the posterior humeral circumflex artery originated from the subscapular artery and was torn during dislocation; such a lesion must occur occasionally, but the vessel contracts and retracts so that no appreciable haemorrhage results.

With the arm by the side and the shoulder dislocated, the nerves in the axilla are more relaxed than in the normal axilla. The same manipulations studied in a normal shoulder were now repeated. Table 2 shows the results of this.

TABLE 2

SHOULDER DISLOCATED

		Traction with arm by the side	Traction at right angle to body	Traction on Hyper-abducted arm
Circumflex nerve	External rotation	0 - 1	0	0
	Internal rotation	1 - 3*	0	1
Radial nerve	External rotation	1 - 2	1	0
	Internal rotation	0 - 3	2	1 - 2
Ulna nerve	External rotation	0	1	0
	Internal rotation	0	1	0
Median nerve	External rotation	0	1	0
	Internal rotation	0	1	0
Musculo-cutaneous nerve	External rotation	0 - 2	2	0 - 1
	Internal rotation	0	1	1

* See text

Legend 0 : Nerve lax, with definite slack.
1 : Moderately taut, with no slack.
2 : Taut, with some side to side movement possible.
3 : Stretched tight, little if any lateral movement possible.

If the arm is pulled downwards and internally rotated the circumflex nerve may be drawn drum tight. The great variation from case to case depends on the relationship of the circumflex nerve to the head of the humerus. If the nerve passes below the head to reach the quadrangular space, as shown in Fig. I, the downward traction and internal rotation will slightly increase the tension on the nerve. However, if the nerve lies hooked over the head of the humerus as in Fig. II. then downward traction pulls heavily on the nerve, and the stronger the traction the more severe the pull on the circumflex.

If the arm is externally rotated the circumflex nerve slips off the head and the drag on it is relieved. But if the arm is internally rotated it is wound around the surgical neck of the humerus and held in close to the under side of the head and severely pulled.

In some cases the radial nerve (and so the posterior cord) is pulled on by the same mechanism, and the tension is always increased by internal rotation which winds the nerve around the shaft of the humerus. The musculo-cutaneous nerve is subjected to

the greatest stretch when there is a combination of downward traction and external rotation.

chance of injury to the circumflex nerve will depend largely on its relationship to the head of the humerus. It would seem

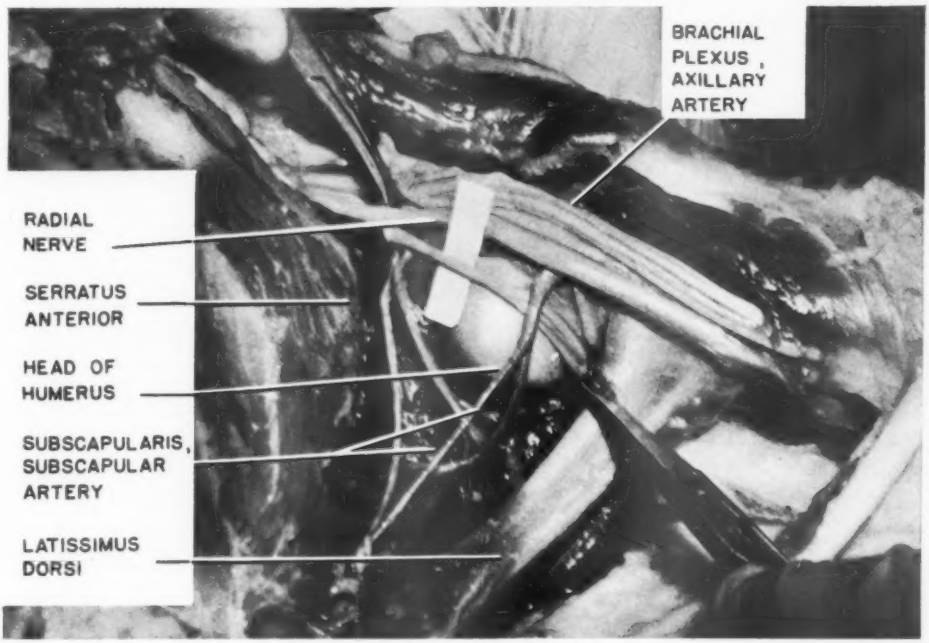

FIG. II.

Traction of the abducted (90°) arm will pull on all the main branches of the brachial plexus, with the exception of the circumflex nerve. The traction of the radial nerve is greatest in full internal rotation, and the musculo-cutaneous nerve in full external rotation.

The nerves are not pulled on to the same extent in the hyper-abducted arm. The distortion of the axillary artery, however, is greatest in hyper-abduction.

DISCUSSION

When considering these findings in the light of the various recommended methods of reduction of dislocation of the shoulder, some factors show that nerve injury may be avoided.

Hippocrates' method — strong downward traction may injure the circumflex nerve or radial nerve, especially if the arm is internally rotated at the same time. The advisable first to externally rotate the humerus fully before traction is applied so that the circumflex nerve will slip off the head and is less likely to be injured. When the internal rotation is full, it should be relaxed before traction is applied to decrease the pull on the radial and circumflex nerves. There is then little risk of nerve damage.

When using Kocher's method, strong downward traction and full internal rotation at the same time, should be avoided. It is important to rotate externally first before internal rotation is carried out.

Traction at 90° abduction as advocated by De Palma (1951), is not likely to injure the circumflex nerve, but the whole plexus is pulled on, and if there is internal rotation the radial nerve (or posterior cord) may be damaged; while external rotation stretches the musculo-cutaneous nerve (or lateral cord).

Traction in hyper-abduction may injure the radial nerve, but is more dangerous because of the extreme stretching of the axillary artery where it is tethered by the subscapular artery. This method is, therefore, most likely to cause arterial lesions. Milch (1938) advocated abduction, external rotation and pulsion as a method of reduction. Although pressure on the head of the humerus is less likely to damage the vessels than strong traction, the gross distortion still occurs, and, therefore, it is probably safer to avoid hyper-abduction.

SUMMARY

A series of dissections of the axilla are described when the arm is in the anatomical position, abducted to 90° and hyper-abducted, and when traction is applied along the arm in these positions. The shoulder joint was first in the normal position and then in the position of a subcoracoid dislocation.

The findings show that downward traction may injure the circumflex, radial or musculo-cutaneous nerves, and the pull on the nerves is increased by internal or external rotation. Traction at right angles to the body pulls on all the branches of the brachial plexus going into the arm, and the radial nerve is especially taut if the arm is internally rotated at the same time.

Traction along the hyper-abducted arm is likely to stretch the axillary artery because it is anchored by the subscapular artery.

Some recommendations are made as to possible methods of avoiding nerve injury during reduction of dislocations of the shoulder.

The mechanism of circumflex nerve damage by stretching over the humeral head when the arm is hyper-abducted during dislocation, as described by Stevens, is confirmed.

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DYSGERMINOMA OF THE OVARY

By F. Forster

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Chenot, in 1911, drew attention to a tumour of the ovary which was very similar to the seminoma of the testis. For many years the classificational position of this ovarian neoplasm remained obscure and it masqueraded under various names, such as *seminoma ovarii*, round cell sarcoma and embryonal or alveolar-cell carcinoma. Then, in 1931, Robert Meyer suggested that this tumour arose from sexually undifferentiated germinal cells and therefore proposed that it be called disgerminoma. Following this, the modified name of dysgerminoma has almost universally been adopted.

In this paper, an attempt has been made to clarify the present status of this tumour. The literature has been surveyed and 12 cases, collected by the writer in the city of Melbourne, have been analyzed. One of these cases (Case 10) has previously been reported (Willis, 1948).

Incidence

Following the almost general adoption of a single term of identification, the dysgerminoma, which had previously been considered to be exceedingly rare, has been recognized far more frequently and, in 1950, Mueller, Topkins and Lapp were able to present an analysis based on 427 cases collected from the literature.

There is some difference of opinion on the rate of incidence of the dysgerminoma. Sailer (1940) reported 5 cases occurring amongst 80 primary malignant ovarian neoplasms but Klaften (1933) had estimated the incidence to be about 3 per cent. This second figure corresponds to Fauvet's (1934) finding, that dysgerminoma occurs about one-third as frequently as granulosa cell carcinoma which in turn makes up about 10 per cent. of all primary malignant ovarian tumours. Furthermore, during the last ten years, in the Gynaecological Department of the Women's Hospital, Melbourne, three cases of dysgerminoma have been present among 108 primary malignant ovarian neoplasms.

Clinical Features

Although dysgerminoma may occur at any age, nearly three-quarters are found in women in the second and third decades of life (Mueller *et alii*, 1950). Its occurrence in childhood, although uncommon, is well recognized (Marek and Philipps, 1947). In the writer's series, the youngest patient was aged 13 years and there were three older than 30, the eldest of whom was 71 years. At the Women's Hospital, Melbourne, an analysis of 100 consecutive solid ovarian neoplasms revealed that only 8 were found in women under 30 years of age, and of these 8, 2 were dysgerminomata.

The clinical presentation of a dysgerminoma, as seen from the cases reported here, is in no way characteristic. The commonest presenting symptoms are abdominal pain and abdominal swelling. The history is usually of short duration.

In early reports (Meyer, 1931) of this condition, stress was laid on its very frequent association with pseudo-hermaphroditism, hermaphroditism and states of anatomical and physiological sexual underdevelopment. However, as more cases have been identified, it is now realized that the majority of these tumours occur in apparently normal women (Seegar, 1938; Novak and Gray, 1938; Pedowitz and Grayzel, 1951) and this was true of 9 of the present 12 cases. As an index of the normal sexual development of most patients, there are many reported instances of pregnancy occurring before and after the removal of a dysgerminoma. This was also observed in the present series. Of the remaining three

of the writer's cases, in one the dysgerminoma developed in an ectopic right ovary situated in the inguinal region (Case 11) and in the other two (Cases 3 and 7) there was evidence of retardation of sexual development. In this minority of patients showing maldevelopment, the clinical history may reveal primary amenorrhoea, a late menarche or scanty and infrequent menses.

There are several reports of pregnancy occurring in the presence of a dysgerminoma, so that, in itself, the tumour does not appear to cause sterility (Ball and Javert, 1948). In one of the cases presented here (Case 2), the tumour caused obstructed labour, and it was removed successfully at the same time as Caesarean section was performed. A similar example was recorded by Stabler and Thompson (1937).

On examination, the tumour is usually found to be unilateral and is more commonly present on the right side. In the series of 427 cases compiled by Mueller, Topkins and Lapp (1950) the tumour was bilateral in 14.8 per cent. of patients, and, when the tumour was unilateral, the right ovary was the site in 58.8 per cent. of cases. In the writer's 12 cases, the dysgerminoma was bilateral in only one instance and the right ovary alone was involved in eight.

The tumour is found most often, clinically, to be of rubber-like consistency and of large size. Of the cases studied here, in only one instance was the diameter less than 12 cm., and in 2 patients a pelvic examination with negative findings had been performed within two years of the removal of large tumours (Cases 7 and 8). This supports the contention that the dysgerminoma is a rapidly growing neoplasm. The tumour is usually freely mobile and any fixation suggests spread to adjoining tissues.

Ascites is occasionally present. Pedowitz and Grayzel (1951), in their series of 17 cases, reported ascites to be present in six. This rate of occurrence, however, appears to be unduly high and, from a study of other series, perhaps about half this frequency should be expected.

Torsion of the pedicle, with symptoms of an acute abdominal crisis, is stated to occur in 5 per cent. of cases (Mueller *et alii*, 1950). This has been the mode of presentation of many of the smaller recorded tumours.

From consideration of these clinical features, it would appear that, in the absence of evidence suggesting a granulosa cell tumour or arrhenoblastoma, any large solid ovarian neoplasm in a girl or young woman should be strongly suspected of being a dysgerminoma. If there is associated sexual maldevelopment, then the diagnosis is almost certain.

PATHOLOGY

Of all the solid ovarian neoplasms, the gross pathological features of the dysgerminoma are usually the most characteristic. In most cases, they enable a diagnosis to be made at operation (Bettinger, 1949). As has already been noted, the tumour is commonly large. Whilst its fibrous capsule remains intact, it retains the general shape of the ovary and its surface is then smooth or slightly nodular. The cut surface presents a glistening, homogeneous, solid appearance (Fig. I) and is of a greyish-pink colour. The tissue is soft or "rubbery" and often friable. Both in consistency and appearance, the tumour substance has been likened to brain tissue. There may be yellowish zones of degeneration and areas of haemorrhage and liquefactive necrosis (Fig. II).

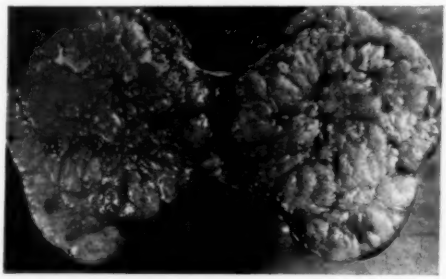

FIG. I. Photograph of the tumour from Case 7 showing the cut surface; the typical glistening, homogeneous, solid appearance is apparent. It measured 13 cm. in long diameter.

The histological structure of the dysgerminoma is even more characteristic. Cells are arranged in groups or strands separated by connective tissue septa in which infiltrations of small round cells, generally presumed to be lymphocytes, are present (Fig. III). The

basic cells are large, round or polyhedral in shape, and have a moderately abundant, clear cytoplasm and a large, hyperchromatic nucleus (Fig. IV). Nucleoli may be prominent (Fig. V) and mitotic figures are to be found. Some tumours are extremely cellular with very little stroma but, in others, the fibrous tissue is very pronounced (Fig. VI) and may show hyaline changes (Fig. VII).

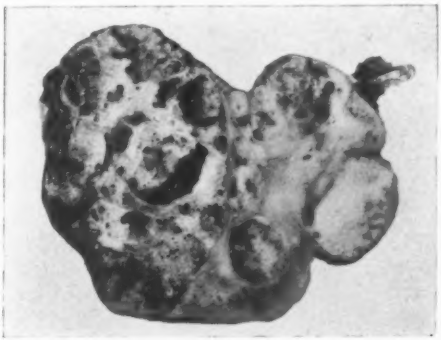

FIG. II. Photograph of the tumour from Case 12 showing the cut surface of the left tumour; there are numerous areas of haemorrhage and extensive necrosis. It measured 15 cm. x 10 cm.

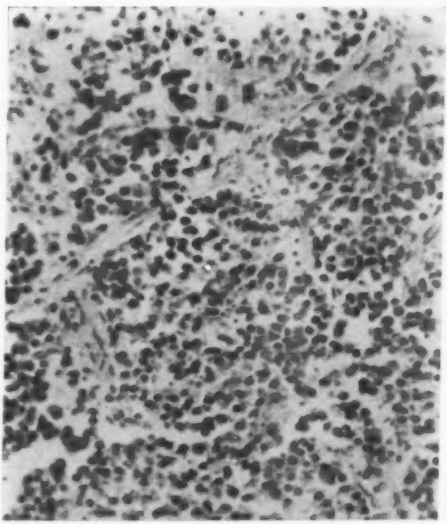

FIG. III. Photomicrograph of a section of the tumour from Case 5. It shows the typical microscopic pattern; there are nests of cells separated by connective tissue septa in which there are infiltrations of small round cells. (x 110)

There does not appear to be any definite or constant correlation between the histological structure and the clinical course of these tumours. It has been stated (Fauvet, 1934; 1936), although the view is not generally accepted (Seegar, 1938; Novak and Gray, 1938), that the more malignant dysgerminomata show loss of the general pattern due to extreme cellularity and paucity of connective tissue. In the present series, these features of gross cellularity were observed in two primary tumours and these cases (Cases 6 and 12) both terminated fatally. In the tumours of the other three patients who died, the typical microscopic structure was initially present. Seegar (1938) has shown that the number of mitoses found has no prognostic significance.

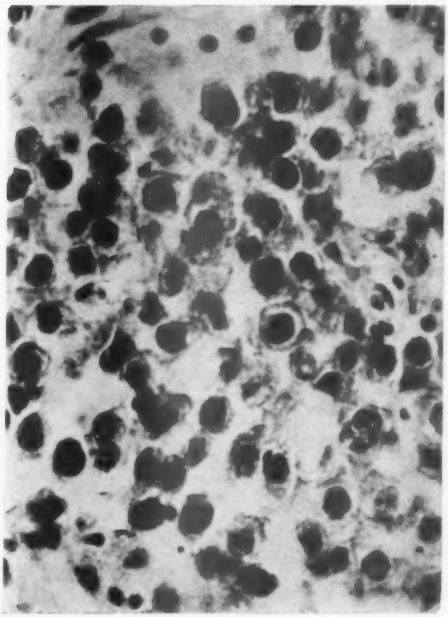

FIG. IV. Photomicrograph of a section of the tumour from Case 5. It shows the large cells, with hyperchromatic nuclei, characteristic of the dysgerminoma. (x 600)

In only two of the writer's cases was there any deviation from the above histological picture. In Case 10, large multinucleated giant cells were seen (Fig. VIII). These were different in appearance from those giant cells which have not infrequently been reported in dysgerminomata adjoining

areas of degeneration and which resemble the Langhans' cells of chronic inflammatory lesions. In Case 7 there were present, in the connective tissue septa between lobules, scattered folliculoid structures which appeared to be formed by granulosa cells (Fig. IX and X).

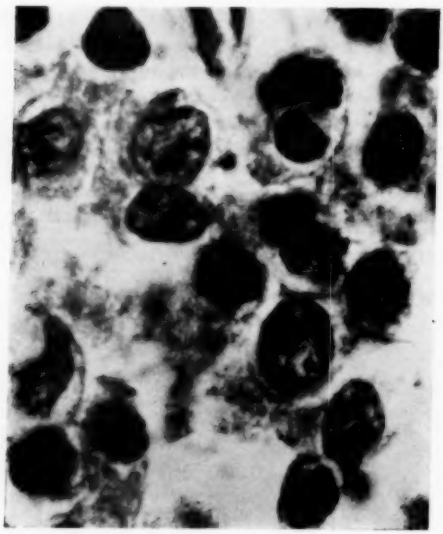

FIG. V. Photomicrograph of a section of the tumour from Case 5. This shows in detail the cell structure. Nucleoli are prominent. (x 1100)

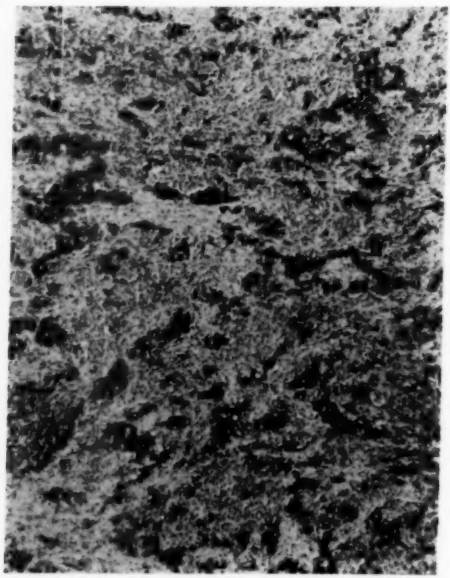

FIG. VI. Photomicrograph of a section of the tumour from Case 7. This is a tumour in which there was a predominance of fibrous tissue. (x 35)

Dissemination of this tumour may occur by any of the usual routes. Next to the pelvic cavity where growths occur from local pelvic and peritoneal spread, the most common sites of metastases are the preaortic lymph nodes and the liver. The lungs, contrary to what was once thought (Seegar, 1938), are often involved (Mueller *et alii*, 1950; Pedowitz and Grayzel, 1951). Secondary deposits have been reported in most tissues and organs of the body (Mueller *et alii*, 1950).

The dysgerminoma has been reported in association with other ovarian neoplasms (Seegar, 1938; Pedowitz and Grayzel, 1951). These have been the granulosa cell tumour, teratomata and chorion-epithelioma. Such cases (none was seen in the present series) are of great interest in relation to the histogenesis of ovarian tumours.

HISTOGENESIS

The histogenesis of the dysgerminoma remains a matter of controversy. The most commonly accepted hypothesis is that of Meyer (1931) who proposed that this tumour arose from germinal cells before they become sexually differentiated. This concept has been considered adequate to explain the fact that a similar tumour, the seminoma, may be found in the testis. The very frequent occurrence of the dysgerminoma in the younger age-groups and its development in cases of sexual maldevelopment have been considered as supporting evidence, for it is argued that in these women there is a greater likelihood of such cells being present. Seegar (1938) has pointed out that the development of the right ovary is later and less complete than the left and thus, similarly, the increased incidence of dysgerminoma in the former organ may be explained.

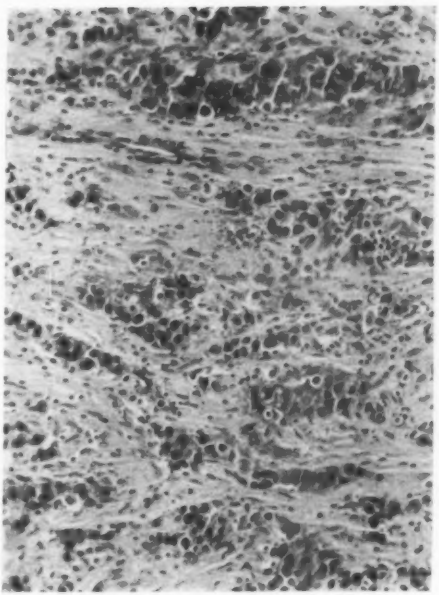

FIG. VII. Photomicrograph of a section of the tumour from Case 7. This is a higher power view of the tumour seen in Fig. VI. (x 110)

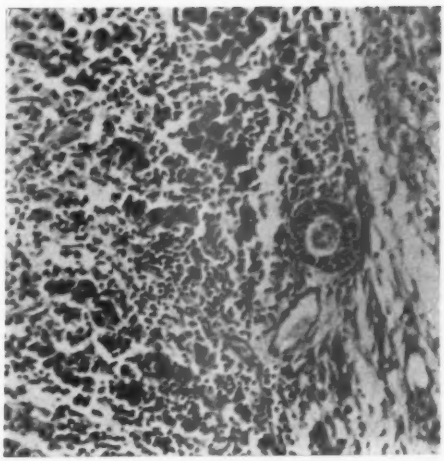

FIG. IX. Photomicrograph of a section of the tumour from Case 7. It shows a folliculoid structure lying in the connective tissue between lobules of a dysgerminoma. (x 110)

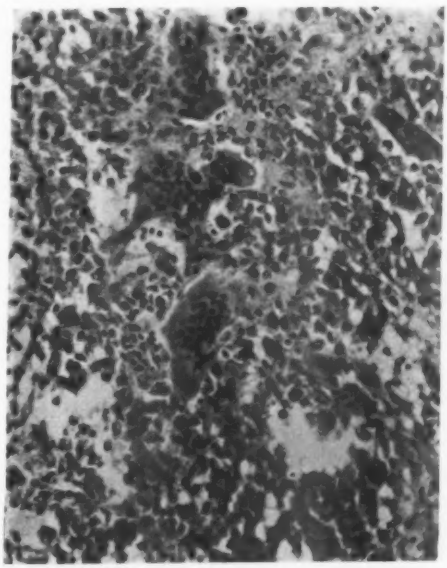

FIG. VIII. Photomicrograph of a section from the tumour from Case 11. This shows the presence of multi-nucleated giant cells. (x 110)

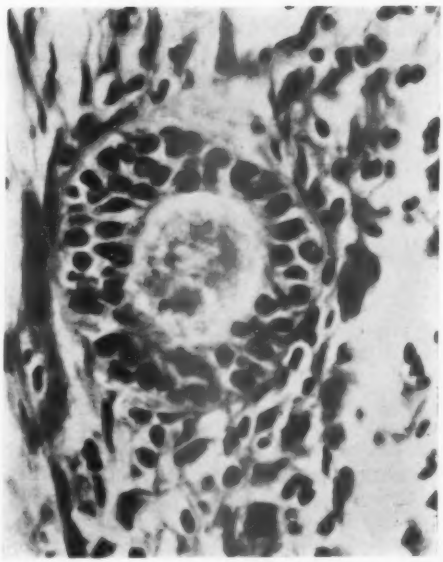

FIG. X. Photomicrograph of a section of the tumour from Case 7. It gives a higher power view of Fig. IX to show the folliculoid structure in more detail. (x 400)

Recently Pedowitz and Grayzel (1951) have criticized this theory. They do not consider that it explains those cases in which a dysgerminoma is associated with another ovarian tumour, unless it is postulated that these represent two separate co-incidental neoplasms from different cell origins. One must agree with them, in accepting the second occurrence to be extremely improbable, in view of the rarity of these tumours. They therefore proposed that the dysgerminoma must arise from totipotent cells of the primitive gonadal mesenchyme which are capable of differentiating in any direction. It is considered by the writer that this further hypothesis is unnecessary, for it would seem unlikely that the undifferentiated germinal cells, from which Meyer suggested this tumour arose, should not possess some possibility of differentiation beyond the usual picture of the dysgerminoma. Teilum (1944, 1946), from his studies of homologous and mixed tumours of the ovary and testis, believes that this occurs and considers that not only are the dysgerminoma and teratoma basically related, but that the primary gonadal chorion-epithelioma and the mesonephroma (as described by Schiller [1939] and which Teilum regards as being derived from extra-embryonic mesoblast) are derived from the same cells as the dysgerminoma. He agrees with Meyer that these are germinal cells, but considers that they have undergone a certain degree of male differentiation which would explain the greater frequency of these homologous neoplasms in the testis. In the ovary, Teilum regards the site of this testicular anlage to be the medullary cords.

The only other theory of histogenesis of the dysgerminoma, which is commonly quoted, is that of Ewing (1940), who believed that this tumour, although derived from the sex-cell series, represents the one-sided development of a teratoma. He considered that the testicular seminoma was of similar development, but as Willis (1948) has pointed out, residues of teratomata are not found in the ordinary seminomata and "the concept of submergence of these by seminomatous growth lacks substantial evidence and is wholly imaginary." These statements would appear to be equally applicable in the case of the dysgerminoma.

As with many other tumours in the body, we have here a stupendous superstructure of hypothesis without any adequate framework of observation for its support. Current hypotheses depend on a philosophy of embryology and morphology which is rapidly becoming outmoded and no attempt will be made here to add to what is probably only an ephemeral confusion.

HORMONAL ASPECTS

Comprehensive endocrine studies of this tumour are few and many of the reports, at present, are conflicting. In accord with Meyer's concept of the sexually undifferentiated nature of the cells, it is found that, in most instances, the dysgerminoma is biochemically inactive. This is supported by the observation that, almost always when maldevelopment is present, removal of the tumour causes no change in the sexual status of the patient.

However, in some patients a positive Aschheim-Zondek test has been noted (Pedowitz and Grayzel, 1951; Potter, 1946; Ber, 1949). In some, but not all of these cases, areas resembling chorion-epithelioma have been observed, either in the primary tumour or in metastases. Teilum (1944, 1946) would explain the positive Aschheim-Zondek test, even in the absence of recognized areas of apparent trophoblast, on the basis of the close histogenetic relationship which he believes exists between the dysgerminoma and the primary gonadal chorion-epithelioma. Following removal of the tumour, a positive Aschheim-Zondek test should become negative within two or three weeks; if it does not, then this is strong evidence of the presence of metastases (Pedowitz and Grayzel, 1951).

That the dysgerminoma very occasionally may have some endocrine influence is also suggested from the rare cases in which there is some change in the anatomical and physiological sexual status of the patient following its removal (Selye, 1947; Gough, 1938). In Case 3 of the present series, a young woman of 22 years who had never menstruated, removal of a dysgerminoma was followed by the appearance of regular menses. In Case 7, a less significant effect on menstruation was also observed.

In none of the cases in the present series were hormone analyses performed. It is urged strongly that these should be carried out whenever possible, for it is only in this way that the present conflicting results may be clarified.

PROGNOSIS

A detailed study of the prognosis of the dysgerminoma is of importance because, as will be seen, it has considerable bearing on treatment.

There has been a gross difference of opinion on the degree of malignancy of this neoplasm. Early reports gave a more optimistic outlook than now appears warranted. Meyer (1931) stated simply that many cases remained permanently cured without recurrence. Schiller (1936) emphasized its benign nature. However, recently Mazel (1947) and Pedowitz and Grayzel (1951) have concluded that this tumour is highly malignant and consider that radical surgery (total hysterectomy and bilateral salpingo-oophorectomy) followed by radiotherapy is indicated in every case. Novak's views (1952) are not as extreme as these, although he recognizes that the prognosis is more serious than is thought by many. This diversity of opinion seems to be consequent upon the rarity of the dysgerminoma and the tendency, therefore, to draw conclusions from too small a number of cases.

Mueller, Topkins and Lapp (1950), in their review of 427 cases collected from the literature, state that 106 of these were not traced after operation. Of the remaining 321 cases, the death of 88 could be attributed to the tumour, whilst 18 died from other causes. They noted that 79 patients were alive and well five or more years after operation and that 136, although well, had not reached the five year mark. Of more significance was their finding that, of 49 cases in which the tumour involved one ovary and of which the capsule was intact, 44 were alive five or more years later. They do not state what the treatment was in these cases but, from a personal review of the literature, it would seem that in most instances it was only salpingo-oophorectomy.

Of the writer's 12 cases, 5 have died as a consequence of the tumour, 5 are alive and well five or more years after operation, and in 2 instances the patients, although well, have not yet reached the five year mark. In 9 cases the tumour was unilateral and its capsule was intact. The surgical treatment in each of these was salpingo-oophorectomy and three had post-operative radiotherapy. Of these 9, 5 patients are alive and well five or more years after operation, 2 are alive and well but have not yet reached the five year mark, and 2 have died from recurrences (in one of these cases [Case 6] there was an attempt at aspiration of the tumour prior to its removal).

Therefore, it would seem that, although the dysgerminoma is undoubtedly a malignant neoplasm, its nature is such that its rapid growth may give rise to symptoms, drawing attention to it, before the occurrence of invasive perforation of its capsule and before lymphatic and blood-borne spread, both of which are apparently usually late phenomena. Because of these latter factors, the prognosis of a dysgerminoma is not as serious as that of the more common primary carcinomata of the ovary.

However, once perforation of the capsule does occur or metastases are present, the outlook becomes very grave. It is also found that (as is true of many tumours of different kinds) bilateral ovarian involvement and ascites, especially if haemorrhagic, are of ill-omen.

As has already been stated, the histological character of the tumour in the present state of knowledge is of little help in determining the prognosis.

MANAGEMENT

From the preceding considerations, it is felt that treatment can now be more logically defined.

It is believed that conservative surgery, simple salpingo-oophorectomy, should only be employed in girls or young women of normal sexual development in whom the preservation of the childbearing function seems desirable despite the slightly greater risk of recurrence. In these cases, the tumour must be unilateral, its capsule must be intact

and there must be no suspicion of metastases (the parametria, the pelvic and preaortic lymph nodes and the liver should be palpated at operation). The patient, postoperatively, must be carefully observed by regular examinations and, because of recorded instances of recurrence not being manifest for several years, it is felt that there should be no time limit to the "follow-up." If a recurrence does appear, then further surgical intervention and radiotherapy, as indicated, becomes necessary.

In all other cases, it is considered that treatment should consist of a full-scale attack by radical surgery followed by radiotherapy. In most instances total hysterectomy and bilateral salpingo-oophorectomy is all that is surgically necessary, but this procedure, if indicated, may have to be extended; for example, Dockerty and MacCarthy (1939) reported a case in which a Wertheim hysterectomy with pelvic lymphadenectomy was performed because of involvement of the pelvic lymph nodes and they record that the patient was alive and well seventeen years later.

This tumour, like the similar seminoma of the testis, is generally considered to be extremely radiosensitive (Moreton and Desjardins, 1947; Russo and Kelso, 1949; Heyman, 1950). Cases have been recorded of cure by radiotherapy alone (Seegar, 1938). Regression, following irradiation, of metastases or local recurrences after surgery, has often been noted and in some instances cure has then seemingly been attained (Seegar, 1938; Novak and Gray, 1938; Moreton and Desjardins, 1947).

It is generally accepted that irradiation should not be confined to the pelvis, but, in view of the common sites of spread of dysgerminoma, should include the whole of the abdomen. Heyman (1950) considers that the chest should also be irradiated.

Although many tumours are radiosensitive, there are several reports of instances where there has been little or no response to irradiation (Henderson, 1951; Russo and Kelso, 1949; Pedowitz and Grayzel, 1951). Russo and Kelso (1949), in their case, then administered androgenic hormones in large doses with an apparently beneficial, although temporary, palliative effect. More striking is the recent report of Anderman, Johnson and Hosmer (1952), who, after the failure of radiotherapy, used nitrogen mustard and noted a very significant response; regression of metastases occurred and the patient showed rapid clinical improvement. The administration of nitrogen mustard was repeated on several occasions, but with lessening effect and the patient succumbed three years after initiation of this therapy.

SUMMARY

1. A general survey of the dysgerminoma of the ovary is presented and 12 cases reported.

2. The infrequency of the occurrence of this neoplasm is shown, but the possibility of making a correct provisional preoperative diagnosis, based on the clinical features is seen.

3. The gross pathological features are described in detail for these are usually characteristic and enable a diagnosis at operation.

4. The two cases in the present series in which the typical microscopic pattern of this tumour was lost, due to extreme cellularity and paucity of connective tissue, both terminated fatally.

5. The various hypotheses of the histogenesis of this tumour are discussed; no satisfactory hypothesis exists.

6. It is strongly urged that hormone analyses should be done whenever possible with this tumour to clarify the present conflicting position.

7. The prognosis of the dysgerminoma is discussed in detail and logical lines of treatment deduced from this. It is considered that conservative pelvic surgery should be limited to certain defined cases and that in all other patients a more radical surgical approach should be practised and that this should be then followed by radiotherapy.

TABLE 1

THIS GIVES THE GENERAL FEATURES OF THE 12 CASES DESCRIBED IN THE PAPER

Case No.	Age	Clinical Presentation	Site(s) of Involvement	Treatment	Macroscopic Features	Microscopic Features	Sexual Development	Pursuant Course
1	19	Tender lower abdominal swelling for six months	Right. Well-encapsuled. Left ovary normal	Right. salpingo-oophorectomy	Tumour the size of a small football	Typical pattern	Normal. Always suffered from dysmenorrhœa	Patient alive and well sixteen years after operation. Has never married
2	26	Tumour caused obstructed labour	Left. Well-encapsuled. Right ovary normal	Left salpingo-oophorectomy at Cæsarean section	Tumour weight, 4,300 gm.	Typical pattern	Normal. Patient had had 2 children prior to this pregnancy	Patient alive and well thirteen years after operation. Had fourth child three years later
3	22	Presented with retention of urine	Right. Well-encapsuled. Left ovary normal	Right salpingo-oophorectomy	Tumour diameter 15 cm. Extensive hæmorrhage and necrosis	Typical pattern	Normal genitalia. Had never menstruated	Patient alive and well ten and one half years after operation. Menses have been normal and regular for last nine and one half years
4	20	Vague abdominal pain for three months	Left. Well-encapsuled. Right ovary normal	Left salpingo-oophorectomy	Tumour weight, 2,000 gm.	Typical pattern	Normal. Menstruation normal	Patient alive and well eight years after operation. No pregnancies
5	25	Lower abdominal pain and swelling for four months	Right. Well-encapsuled. Left ovary normal	Right salpingo-oophorectomy. Post-operative irradiation	Tumour weight, 1,250 gm.	Typical pattern	Normal. Patient had one child	Patient alive and well five and one half years after operation. Stormy artificial menopause following radiotherapy
6	59	Abdominal pain and swelling for several weeks	Right. Well-encapsuled. No note of left ovary available	Right salpingo-oophorectomy. Attempted aspiration prior to the removal	Tumour diameters, 20 x 18 x 10 cm. Extensive hæmorrhage and necrosis	Rather more cellular than usual	Normal. Menopause ten years previously. Had had 3 children.	Generalized abdominal involvement, by presumed recurrence and metastases, three and one half years after operation. Despite irradiation, death two months later. No post-mortem
7	25	Found at routine examination	Right. Well-encapsuled. Left ovary normal	Right salpingo-oophorectomy	Tumour diameter, 13 cm.	Much more fibrous tissue than normal. Folliculoid structures present in the septa	Menarche at eighteen years; since menses extremely infrequent and scanty. Genitalia normal. Married four years but no children	Patient alive and well one and a half years after operation. Since operation menses regular every five weeks. Loss normal in amount
8	71	A lump in the lower abdomen for one year	Right. Well-encapsuled. Left ovary normal	Right salpingo-oophorectomy	Tumour diameter, 17 x 11 x 11 cm.	Typical pattern	Normal. Menopause twenty years ago. Had a large family	Patient alive and well ten months after operation
9	13	Abdominal pain for six months	Left, with spread to omentum and peritoneum. Right ovary normal	Left salpingo-oophorectomy. Tumour ruptured during removal	Tumour diameter 12 to 15 cm. Very necrotic	Typical pattern	Pre-menarche	Patient died four months after operation from generalized abdominal metastases. No post-mortem
10	18	Abdominal discomfort and swelling for two months	Right. Encapsuled. Left ovary normal	Right salpingo-oophorectomy	Tumour weight, 3,350 gm.	Typical pattern. More cellular pattern in metastases	Normal	Recurrence in abdomen two and one half years after operation. Radiotherapy. One year later pulmonary metastases. Six months later generalized metastases; death three months later. At post-mortem, metastases widespread
11	33	Lump in right groin for six months	Ectopic right ovary in inguinal region	Local excision		Pattern in parts typical. Elsewhere multinucleated giant cells	Normal. Had one child seven years previously	Local recurrence one year after removal. Radiotherapy. X-ray evidence of metastases in spine and ribs after two and three-quarter years; death several months later
12	22	Abdominal pain for one week	Bilateral and local pelvic spread. Both tumours adherent to adjoining structures	Incomplete removal of both tumours. Irradiation	Right tumour solid, diameter 7.5 x 5 cm. Left tumour very necrotic, 15 x 10 cm. Both showed hæmorrhages	Pattern of both very cellular. Necropsy material very cellular and necrotic	Normal. Menstruation normal	Death two months after operation. At post-mortem, very extensive peritoneal and hepatic metastases. Gross ascites

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ANO-RECTAL SUPPURATION

By E. S. R. Hughes

Royal Melbourne Hospital

ABSCESS formation round the anal canal and adjacent part of the rectum is common, but there is often unnecessary confusion as to the relation of the abscess to the anal canal and rectum, and there is still a sharp difference of opinion as to the best approach to the problem.

Wenzel (1946), in a series of 77 ano-rectal abscess formations, reported that nearly 50 per cent. were ischio-rectal; Gabriel (1948), on the other hand, has found that this type of abscess accounts for only 15 per cent. Lockhart-Mummery (1934) stated that it was never advisable to perform a radical operation for fistula at the time of treating the abscess; he cut away the skin overlying the abscess and allowed it to drain. Miles (1944) also protested against operations designed to lay open the abscess and the extension into the anal canal at the same time. But his technique differed from that of Lockhart-Mummery because he believed it quite unnecessary to remove large areas of skin; the incision and excision of skin was large enough to permit the margins of the wound being sufficiently everted to ensure adequate drainage. Bacon (1949) favours a one-stage operation, but recommends the two-stage procedure for the occasional surgeon. Turrell (1949) holds a similar view; he is very careful to select the case suitable for the one-stage operation.

This paper is based on a consecutive series of 50 ano-rectal abscesses, treated either at the Royal Melbourne Hospital or in private hospitals.

Aetiology

Abscess formation occasionally complicates operations for haemorrhoids and may follow a peri-anal injection for a *fissure-in-ano*. In many other cases infection seems to be a sequel of mucosal cracks caused by the passage of hard scybalous motions, pieces of fishbone, unrecognized fragments of glass, *etcetera*. In 14 cases of this series an abscess had been treated in the same area at some previous time.

The role of anal crypts and anal intramuscular glands in the aetiology of ano-rectal infection is difficult to assess. Proctologists see a number of cases with pain referred to the anal region, and examination shows a tender area localized to an enlarged, oedematous anal papillae; if observed over a period of some months abscess formation may result in the same area.

The organism responsible for the infection varies. The *E. Coli* organism can be isolated from nearly every case; "green" streptococci and other gram positive cocci, difficult to isolate on culture, are often present. *Staphylococcus aureus* is present in a small proportion and very occasionally is the only organism. A pyogenic abscess may occur in the tuberculous individual, and Koch's bacillus might be found in the pus; a pure tuberculous abscess is rare.

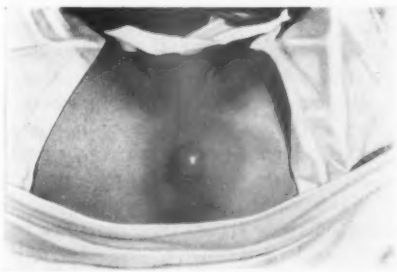


FIG. I. Colour photograph of a peri-anal abscess. Observe the cellulitis extending to the ischial tuberosity.

Surgical Pathology

Ano-rectal infection seen in the early phases often defies classification. This is not surprising because initially there is a cellulitis which has little respect for tissue

planes. Infection causes tissue destruction and suppuration is the result. The resulting abscess is usually confined to one of the recognized spaces around the anal canal.

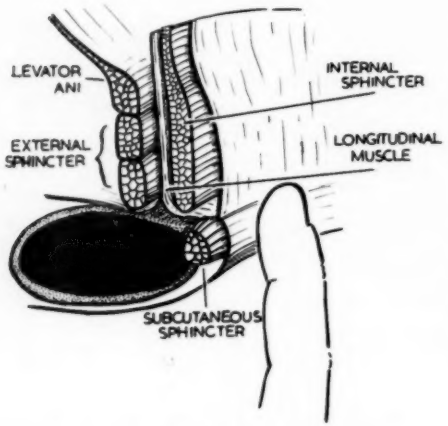


FIG. II. Drawing of a peri-anal abscess.

Peri-anal abscess (40 cases)

This is the most common abscess (Fig. I). The peri-anal space is bounded inferiorly by skin, superiorly by the peri-anal fascial septum, medially by the skin of the anus and anal canal up to the anal intermuscular septum, and laterally it becomes continuous with the subcutaneous tissue (Fig. II). The initial cellulitis may involve a wide area, extending laterally beyond the ischial tuberosity. Complete resolution is uncommon; abscess formation is the rule. The abscess is usually large, containing thick, offensive pus. The walls are lined by necrotic tissue, surrounded by a zone of cellulitis; medially, in relation to the anal canal, the wall is usually thin and friable. Untreated, the abscess discharges spontaneously, either into the anal canal or through the peri-anal skin close to the anus.

Ischio-rectal abscess (5 cases)

Abscess formation within the ischio-rectal space is uncommon. The ischio-rectal space extends up to the sloping roof formed by the *levator ani* and down to the peri-anal fascial septum which separates it from the peri-anal space. Medially the space is bounded by the sphincters of the anal canal and laterally it is limited by the fascia over the *obturator internus* (Fig. III). Posteriorly, the space extends to the sacro-tuberous ligament and the edge of the *gluteus maximus*, and anteriorly it passes over the free edge of the triangular ligament to reach the pubic bone. The ischio-rectal space communicates with that on the opposite side through the post-sphincteric or posterior sub-sphincteric space (Courtney, 1949); this space lies behind the anal canal and is discussed below. Ischio-rectal infection frequently seems to originate in this space so accounting for bilateral ischio-rectal abscess formation. The ischio-rectal fossa is filled with loose, large locules of fat, and apart from leashes of large vessels, notably the inferior haemorrhoidal vessels, it is relatively avascular.

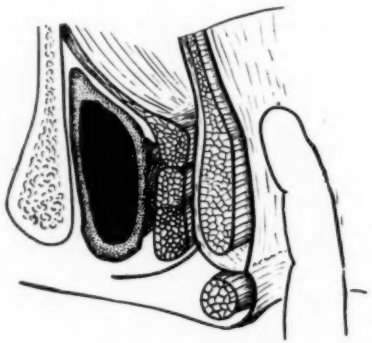


FIG. III. Drawing of an ischio-rectal abscess. The upper level of the abscess extends above the level of the ano-rectal ring, an important diagnostic feature.

Therefore, inflammation is particularly liable to end in necrosis and suppuration. Untreated, the abscess ruptures through the peri-anal skin, or less commonly into the anal canal. It practically never penetrates the *levator ani*, although Miles (1944) illustrates a collar stud abscess with one locule in the ischio-rectal fossa and the other above the *levator ani*. On rare occasions the abscess ruptures into the superficial perineal pouch and pus tracks into the scrotum; the author has experience of one such case, not included in this series, whilst Wenzel (1946) and Sherman, Jenner, and Christianson (1951) mention the possibility of such an occurrence.

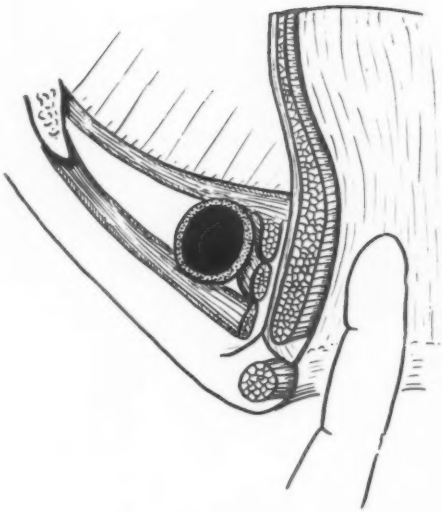


FIG. IV. Drawing to show a post-sphincteric abscess.

Post-sphincteric abscess (3 cases)

The infection may originate in and remain confined to the post-sphincteric space (Fig. IV). This potential space, named the posterior sub-sphincteric space by Courtney (1949), lies posterior to the anal canal, between the coccygeal and cutaneous attachments of the superficial part of the external sphincter and the coccygeal attachments of the *levator ani*. The abscess is often small, but if infection spreads, it does so into one or both ischio-rectal fossa because this space is in anatomical continuity with these two spaces (Fig. V). The post-sphincteric abscess must be distinguished from a dorsal peri-anal abscess caused by infection entering the tissues through a dorsal *fissure-in-ano;* such an abscess lies below the coccygeal attachment of the superficial external sphincter, in the peri-anal space.

Submucous abscess (2 cases)

A submucous abscess lies in the submucous space of the anal canal and adjacent rectum. It extends downwards to the anal intermuscular septum; superiorly, it may pass well beyond the ano-rectal ring into the rectal submucosa (Fig. VI). The vascular mucosa forms a thin inner wall through which the abscess usually bursts spontaneously; extension through the muscular walls of the anal canal is rare but occasionally a collar stud abscess is seen with one locule in the submucosa, and the other in the peri-anal tissues (Fig. VII).

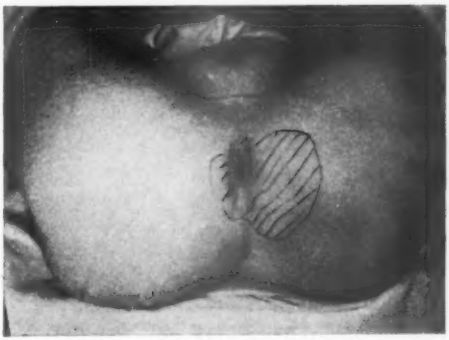


FIG. V. Photograph to show a post-sphincteric abscess with cellulitis of the ischio-rectal fossae. On incision, pus was found in the midline posteriorly but not in the ischio-rectal fossae. A skin pencil has outlined the area of induration noted clinically.

CLINICAL FEATURES

Peri-anal abscess

The outstanding symptom is pain, usually of relatively short duration. The pain is severe, throbbing, and persistent; it is aggravated by sitting, walking, and, to a lesser extent, by defaecation. Systemic symptoms, caused by the infection, are present but are usually secondary to the pain. Inspection of the anal region reveals an area of cellulitis in the centre of an obvious swelling abutting on the anus (Fig. I). The area is acutely tender on palpation. Passing a finger into the rectum reveals at once that the swelling is entirely outside the anal canal and below the ano-rectal ring (Fig. II).

Ischio-rectal abscess

Pain is a later symptom. The patient is aware of a persistent discomfort in the region of the anal canal, but the severe pain of the peri-anal abscess is absent. Toxic symptoms are more obvious. The patient is languid, with a feeling of malaise; his appetite is poor, and he prefers to lie in bed. Some asymmetry of the peri-anal tissues is apparent on inspection; there is

localized tenderness and induration on deep palpation. In more advanced cases there is a zone of superficial, visible cellulitis as is found in the peri-anal abscess. Rectal examination discloses a large tense, tender swelling outside the anal canal, occupying one or both ischio-rectal fossa, and extending well above the ano-rectal ring (Fig. III).

FIG. VI. Drawing to show a submucous abscess.

Post-sphincteric abscess

Like the ischio-rectal abscess systemic symptoms are more notable than pain. There is no skin redness and no visible swelling to betray the presence of the abscess. Examination of the anal canal shows a tender, circumscribed lump, in the midline behind the anus, about the size of a plum (Fig. IV).

Submucous abscess

Systemic symptoms of infection are again more pronounced than pain which is deep seated and ill-defined, and aggravated by sitting, walking and defaecating. There is peri-anal tenderness corresponding to the side of the abscess, but no visible cellulitis or swelling. A rectal examination discloses the abscess extending upwards from the anal intermuscular septum (Fig. VI). It feels superficial, is usually confined to a segment, is acutely painful on pressure, so much so that the examiner finds it very difficult to reach the upper limit of the abscess, but its upwards extension above the ano-rectal ring can be readily appreciated.

DIAGNOSIS

Diagnosis of the type of abscess is usually not difficult. Although most of these infections are termed "ischio-rectal" this rarely is the case. The peri-anal abscess is easily the most common variety.

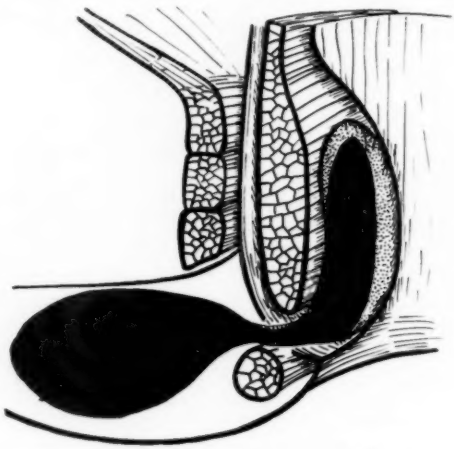


FIG. VII. Drawing to show a collar-stud abscess, with one locule in the submucous space, and the other in the peri-anal space.

The peri-anal abscess is superficial and unilateral; it is usually accompanied by visible cellulitis and never reaches upward beyond the ano-rectal ring. The ischio-rectal abscess is deeply situated, and may be bilateral; its upper limit extends above the ano-rectal ring whilst the lower boundary is separated from the skin by the peri-anal space. The post-sphincteric abscess presents as a tender lump, the size of a plum, in the midline posteriorly, and in the region of the ano-rectal ring. The submucous abscess is superficial within the anal canal, extends down to, but not lower than the anal intermuscular septum; the upper limit is difficult to reach even when palpation is done under anaesthesia but is above the ano-rectal ring; there is no swelling nor induration within the ischio-rectal fossa.

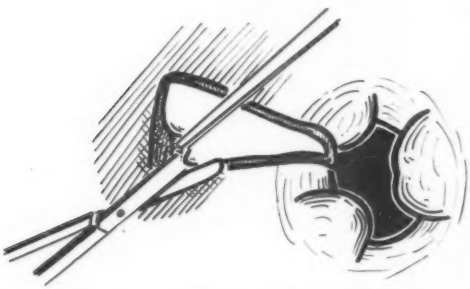
TREATMENT

Cellulitis of the tissues around the anal canal rarely resolves completely; suppuration is the rule. Pus forms at an early stage and by the time the patient reaches the

surgeon, the abscess is often large. Therefore, as a rule, it is not necessary for the surgeon to delay unduly his incision in the hope that the infection will subside or in the belief that pus had not yet formed. In some cases seen soon after the onset of infection the surgeon is undecided as to the exact situation of the pending abscess; in these circumstances he must be cautious in his approach, and await localization.

One-stage operation

Some surgeons favour a radical operation. The operation is designed not only to drain the abscess but to prevent the later development of a *fistula-in-ano*. This entails widely unroofing the abscess, finding any communication with the anal canal, and removing the overlying tissue (Fig. VIII), and careful post-operative dressing to ensure that the cavity so saucerized heals evenly from the depth and from the edges.



ABSCESS INCISED AND UNROOFED

FIG. VIII. Drawing to illustrate the one-stage operation. The abscess with the track into the anal canal is unroofed. The wound takes a considerable time to heal.

The method has disadvantages. The most important is the difficulty in locating the communication with the anal canal; if not found the operation is unlikely to be successful. The inflamed tissues are friable and the greatest care is necessary to avoid creating a false passage with the probe when searching for the original opening.

The second serious disadvantage of this radical operation resides in the prolonged stay in hospital that it entails. This often is responsible for serious economic setbacks to the patient in whom the illness has appeared swiftly and unexpectedly to be followed by some weeks of enforced inactivity.

Two-stage operation

The most satisfactory method of treatment is a two-stage operation. The first operation entails simple incision of the abscess. The incision is placed over that part of the abscess nearest to the surface. The incision is large enough to admit the finger, and after the locules have been gently broken down, the edges of the wound are trimmed away so that the incision will not become sealed too early (Fig. IX). A rubber drain tube, or a piece of gauze can be inserted to promote drainage. The pus is cultured and antibiotic sensitivity tests performed on the isolated organism; antibiotics can be given post-operatively if necessary but the infection settles down fairly quickly without them. The patient need only stay two or three days in hospital and is usually able to return to work a day or two later. The inflammation subsides in some cases apparently completely; the wound closes and soon can be seen only with difficulty. No further treatment is necessary in these cases, but they should be examined from time to time. Aronsson (1948) has found that 60 per cent. will heal completely; in this series 31 patients treated by simple incision were traced and only 8 have remained quiescent. In the remainder, the inflammation gradually subsided to leave a palpable linear fistula track leading from the incision towards the anus.

The second stage is the treatment of the fistula. The patient is readmitted at a later, more convenient time. A pre-operative course of intestinal sulphonamide (10 grammes daily for five days) precedes the operation; the fistula is laid open in the usual way. If allowed to heal by granulation tissue the wound takes several weeks to heal, during which time the surgeon must closely supervize the dressings to avoid pockets forming and the fistula recurring. The most satisfactory procedure is to apply a split skin graft to the wound after the fistula has been excised. The dressings are left undisturbed for four days and are then removed. The bowels open the same or the next day, and

the patient can leave hospital a week after admission with the wound almost, if not completely healed (Hughes, 1952).

too small an incision at the first operation because the wound may seal off too soon and infection may linger for some time.

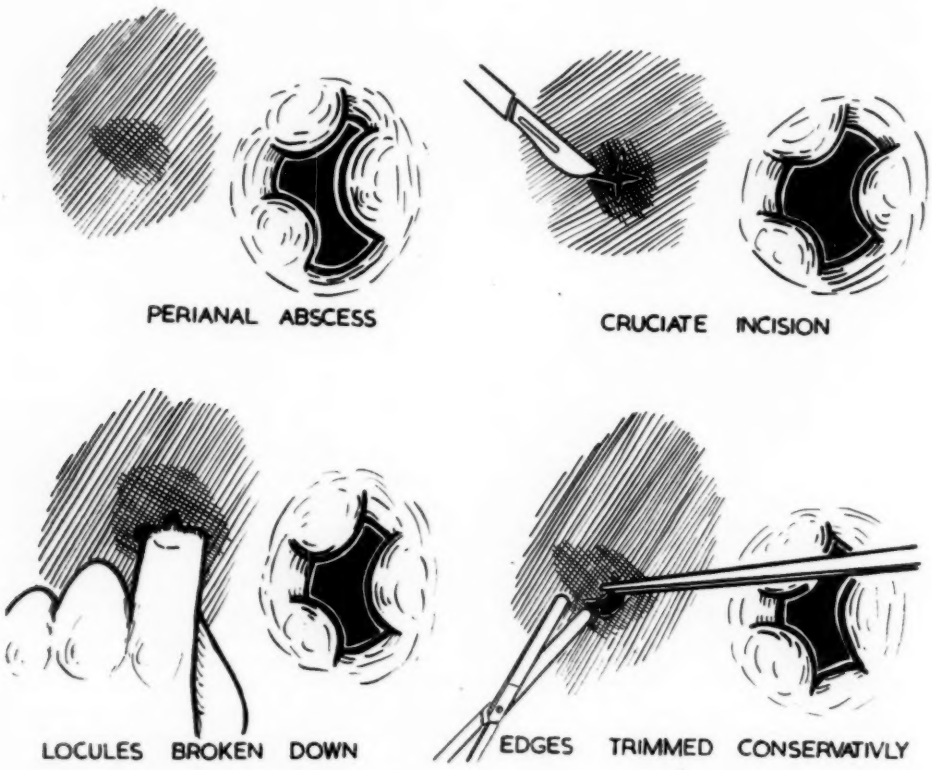


FIG. IX. Drawing to illustrate the first stage of the two-stage operation. The surgeon deliberately aims at securing a *fistula-in-ano*, later treated by excision and skin graft.

Two operations are necessary with this technique and this constitutes the most important disadvantage, as staged procedures are never as acceptable to the patient as the single operation. But this disadvantage is apparent rather than real, because of the frequency of failure of the one-stage radical operation to effect a cure. The most important advantages of this two-stage operation are to be found in the much greater certainty of cure, and the considerable reduction of time in hospital which, at the same time, is made more selective. The surgeon must be careful to avoid making

The ischio-rectal and post-sphincteric abscesses are treated in the same manner outlined for the peri-anal abscess. The submucous abscess is opened into the anal canal by pushing blunt artery forceps through the oedematous mucosa; if a submucous fistula persists it will require treatment subsequently.

PELVI-RECTAL ABSCESS

The pelvi-rectal abscess is one situated above the *levator ani* and alongside the rectum; such an abscess has not been encountered in this series and the author has

no personal experience in their management. This type of abscess has, therefore, been omitted from the classification.

SUMMARY

Most infections around the anal canal and rectum result in a peri-anal abscess. This type of abscess is more than eight times more common than the ischio-rectal abscess and is responsible for four out of every five abscesses in the region. These abscesses are best treated by a two-stage operation; a fistula is allowed to form as a result of the first operation, and this is treated subsequently by excision and primary skin graft. An attempt to cure by a one-stage operation, wherein the abscess cavity is widely laid open, including the track into the anal canal, is fraught with uncertainty and is uneconomical.

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THE VAGAL BODY AND ITS TUMOUR

By J. H. W. Birrell

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"To a philosopher, no circumstance,
however trifling, is too minute."
Goldsmith:
The Citizen of the World.

SINCE the first recognition of the carotid body by von Haller in 1743, a number of other small masses of similar tissue has been described and the known branchial glomera or, as they are commonly described to-day, non-chromaffin paraganglia may be enumerated thus:

1. The jugular or tympanic body situated in the jugular bulb of the skull and along the course of the tympanic nerve; this body was described fully by Guild in 1941. The tympanic portion had been described earlier, according to Berg (1950), by Krause (1878).

2. The vagal body — *paraganglion juxta-* or *intra-vagale*—situated in, or in juxtaposition with, the vagus nerve at the level of, or immediately below, the *ganglion nodosum.*

3. The carotid body.

4. The aortic bodies one of which is situated at the junction of the innominate and right subclavian arteries and the other at the junction of the aorta and left subclavian arteries. These bodies were described first by Muratori (1934) in animals and named the aortic *glomi* by Nonidez (1935).

5. The pulmonary bodies, the superior body being found in the angle between the pulmonary artery and the left coronary artery, whilst the inferior body is found between the aortic arch and the *ductus arteriosus.* These bodies were fully described first by Palme (1934) as the *paraganglia supracardiale superius et inferius.*

Recently, Barnard (1946) has described another paraganglion, which is constant in its situation, in this area between the pulmonary artery and the *ductus arteriosus.*

The vagal body then is a definite discrete portion of a widely distributed specialized neuro-vascular tissue.

General Considerations

The exact nature of these bodies has been frequently discussed and they have been classified in a number of different ways. Thus, early in this century, following Kohn's (1900) work, they were regarded as analogues of the suprarenal medulla and were classified as chromaffin paraganglia. This misconception—for they neither give a definite chromaffin reaction nor do they resemble the adrenal medulla in any other significant manner—is still widespread as indicated by the statement of Russell (1949) that they "closely resemble the adrenal medulla in origin, structure and staining characteristics." Recently the term of non-chromaffin paraganglion has gained the acceptance of general usage.

Viewing these masses of tissue as essentially similar in nature and having regard to the known chemo-receptor functions of the carotid and aortic bodies it is probably best, in the light of our present incomplete knowledge, to retain the non-committal term "body," grouping them as chemo-receptor bodies.

The functions of the carotid body in particular have been relatively fully investigated over the years; these structures lend themselves best to experimental work so obviously (for reasons of accessibility and size) that, as yet, it is mainly by virtue of morphological similarity that the other bodies are presumed to have a chemo-receptor function. The carotid body, however, is undoubtedly the "leader of this chemo-receptor orchestra" since there is relatively little chemo-receptor activity detectable

after its denervation (Comroe, 1939). Continuing this metaphor, the conductor of the orchestra is anoxia with a subnormal oxygen tension (Dripps and Comroe, 1944) while severe alterations in the pH of arterial blood, temperature changes and extreme variations in carbon dioxide tension may all play a part under certain circumstances. In the case of carbon dioxide the effect on the respiratory centre would override any chemo-receptor activity at least whilst the brain is intact.

The other bodies in this chemo-receptor system do, however, undergo pathological changes similar to those observed in the carotid body and indeed they do so at the same time (Kipkie, 1947; Lattes and Waltner, 1949; Lattes, 1950). The only pathological change of importance known at the present time is that of tumour formation, the production of "chemodectomata" (Mulligan, 1950) having been described for most of the chemo-receptor bodies.

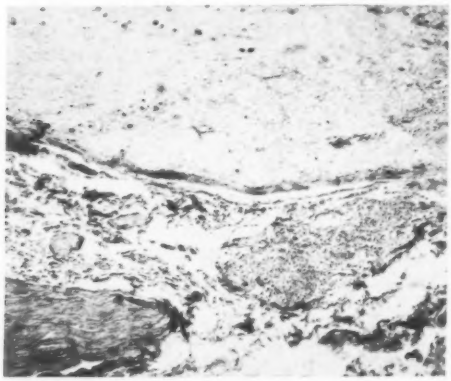

FIG. I(a) Low power photomicrograph of vagus nerve at the level of the *ganglion nodosum* showing the general topography of a portion of the vagal body. (x 18)

THE VAGAL BODY

Muratori, in 1932, described in birds what he regarded as a parasympathetic ganglion situated within and on the surface of the vagus nerve at the level of the *ganglion nodosum*. White (1935) recorded in human beings the presence of a small mass of tissue, closely resembling the carotid body, situated below the *ganglion nodosum*. Seto *et alii* (1950) studied the root part of the human vagus nerve, in frozen sections stained by a modification of Bielschowsky's silver method, and found small groups of cells with a structure similar to that of the carotid and aortic bodies. The cell groups generally were of small size and scattered irregularly throughout the *ganglion nodosum* of the vagus nerve, chiefly in the connective tissue between the bundles of nerve fibres. Histologically, they found that the cells were all "clear" with a round or ovoid nucleus and grouped to form lobules which were invested by the inter-lobular connective tissue. These authors stated that the lobules were very vascular and they described an extracapsular plexus of nerve fibres mainly from the vagus but with a few fine sympathetic fibres. These fibres entered the parenchyma, being widely distributed throughout each

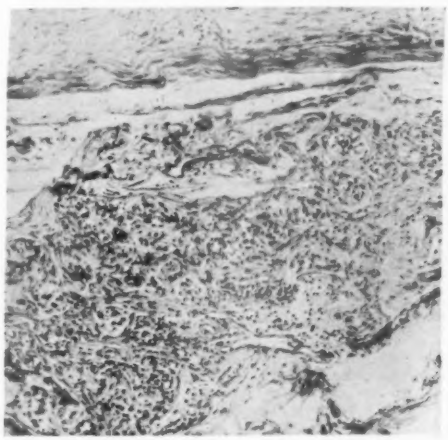

FIG. I(b) Low power photomicrograph of a section of the vagus nerve at the level of the *ganglion nodosum*. Portion of the vagus nerve may be seen above the vagal body, the "glomerular" structure of which is well demonstrated. (x 50)

lobule. The end branches formed a complicated network of fine anastomoses lying in close apposition to the parenchymal cells.

Lattes (1950) figures the vagal body as a compact mass of tissue lying in the vagus nerve below the *ganglion nodosum*.

The vagal body in human beings, is a somewhat diffuse lobulated mass of vascular cellular tissue the general appearances of

which are well seen in Fig. I. It is irregularly distributed round and through the vagus nerve at the level of the *ganglion nodosum* (Fig. II) and commonly a large part of the body may be found directly beneath the sheath of the nerve. It bears an extraordinarily close resemblance histologically to carotid body tissue, consisting of lobules of various sizes surrounded by connective tissue which is very vascular. Each lobule consists of a number of "glomeruli," which typically contain two types of cells (Fig. III).

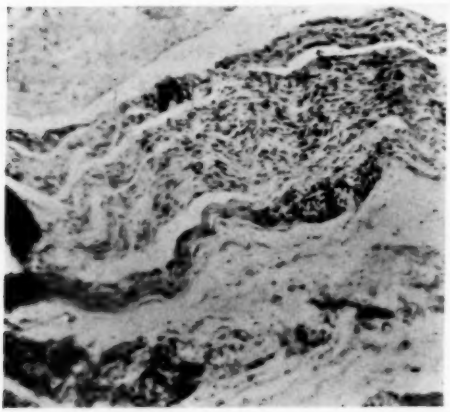

FIG. II. Low power photomicrograph of a section of the vagus nerve at the level of the *ganglion nodosum* illustrating the distribution of the vagal body. One portion may be seen on the right of the figure, intermingled with nerve fibres whilst a larger portion of the body may be seen below on the left in a space between the nerve bundles. (x 30)

The first and predominant type is a polyhedral cell with finely granular cytoplasm and large pale-staining vesicular round or ovoid nucleus. The second type, and there are only a few in each glomerulus, is a smaller cell with a deeply-staining nucleus which is eccentric in position. There are spindle-shaped cells with ovoid nuclei present which can be recognized as forming the walls of blood vessels while mast cells are also present. The glomeruli show a number of sinusoidal vessels lined by endothelial cells. Few if any of the vessels in the body show elastic tissue.

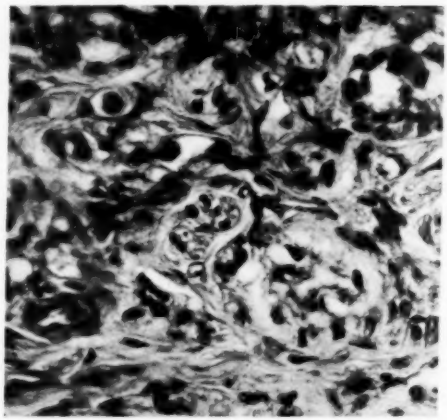

FIG. III. High power photomicrograph of a section of a vagal body showing the glomerular structure. Both types of cell may be seen whilst a number of sinusoid-like vessels also are shown. (x 350)

A comprehensive nerve innervation is found using a modification of a method described by Willis (1945). The terminal twigs may be seen ramifying on the parenchymal cells, the endings being of both ring and club forms (Fig. IV). In general, the mode of innervation of the vagal body is identical with that portrayed by de Castro (1928) for the carotid body.

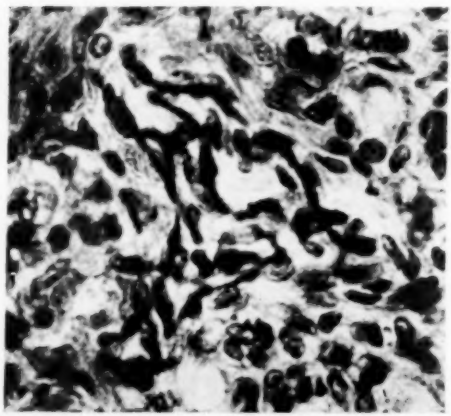

FIG. IV. Photomicrograph of a section of a vagal body stained specifically for nerve tissue. The mode of glomerular innervation is shown both ring-shaped and club-shaped nerve endings, terminating on parenchymal cells, being apparent. (x 350)

VAGAL BODY TUMOUR

The vagal body, as is the case with the other members of the chemo-receptor system, can give rise to so-called tumours; it is proposed in this paper to record a case of carotid body-like tumour arising in the vagus nerve just below the skull, that is, a vagal body tumour.

CASE REPORT

The patient, a married woman aged 36, presented first in October, 1949, complaining of a swelling high up in the right side of her neck, which had appeared first, shortly after removal of her tonsils, some eleven years previously. The lump had remained stationary as a small nodule for a considerable time, but for the last two or three years had been slowly increasing in size. When this swelling first appeared the patient had suffered from "giddy turns" but these had been absent for some years. There was no alteration in breathing, swallowing, phonation or facial movements. Over the last two or three months her thyroid gland had also swollen and this swelling was associated with a rapid heart action.

On examination of the upper part of the neck, a soft rubbery swelling, which had ballooned the right tonsillar fossa, was found in the right lateral wall of the pharynx and this had pushed the wall of the oropharynx almost to the midline of the palate. Inside the pharynx, on the anterior aspect of the swelling, a definite arterial pulsation, which was presumed to be due to the internal carotid artery, was seen. The swelling was limited above by the upper margin of the soft palate and it extended below as far as the hyoid bone. It showed a smooth regular surface and had a resilient consistency. On the outer surface of the neck a similar swelling, continuous with that in the pharynx, presented between the angle of the mandible and the mastoid process. The tumour was deep to the sternocleidomastoid muscle and showed no fluctuation.

A subtotal thyroidectomy was performed in November, 1949, and after an uneventful convalescence the tumour was explored in January, 1950.

The approach was through an incision parallel to the anterior border of the sternocleidomastoid muscle after which the muscle was divided transversely at its upper insertion. The tumour was found to be covered by a network of blood vessels and appeared "like a naevus" and this extreme vascularity caused some technical difficulty in adequately exposing the firm but elastic tumour. This was freed by careful dissection everywhere but above where it was found to be firmly adherent to the base of the skull in the region of the jugular foramen where there was great difficulty, both in demonstrating the relations of the tumour and then in freeing it. The vagus and hypoglossal nerves and the sympathetic trunk were not separately identifiable and they appeared to merge into a fibrous sheath apparently continuous with the internal jugular vein. A cavity, the size of a large hen's egg, through which the internal carotid artery ran a sinuous course, remained after removal of the tumour.

The patient's post-operative course was uneventful save for the presence of a right recurrent laryngeal nerve palsy and paralysis of the right half of the tongue. At the time of writing the patient remains well. Swallowing and phonation are satisfactory although there is still a right recurrent laryngeal nerve palsy and partial atrophy of the right side of the tongue.

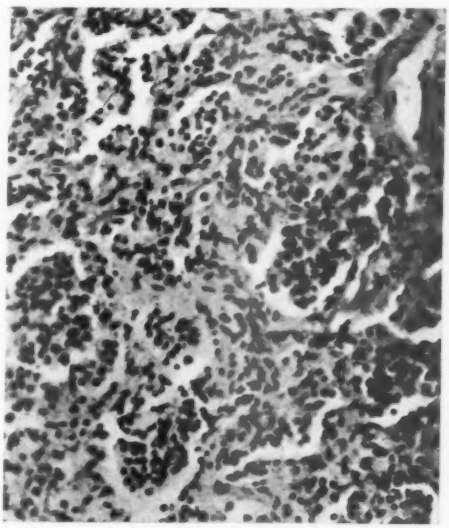

FIG. V. Photomicrograph of a section from the vagal body tumour showing its general appearance. The glomerular structure similar to the normal body can be made out although the proportion of vascular fibrous tissue is increased. (x 150)

Pathological Examination. Macroscopically the tumour was greyish in colour and encapsulated. It was almost spheroidal in shape measuring approximately 5 cm. x 4 cm. The cut surface was of a greyish red colour with a few small haemorrhagic areas. Its consistency was firm but elastic. The vagus nerve could not be distinguished entering the tumour.

Histologically, the tumour is composed of nests and cords of cells arranged in irregular alveoli in which are found a number of thin-walled vessels (Fig. V). The alveoli are separated by a considerable amount of fibrous stroma which, however, is very vascular. The cells which make up the alveoli are of two distinct varieties.

The first type contains a pale, ovoid vesicular nucleus and possesses faint granular cytoplasm. The second type shows a very dark round or ovoid nucleus which is eccentric and appears almost

pyknotic (Fig. VI). This cell contains a relatively small amount of cytoplasm. The first type forms the majority of cells present in well-preserved areas of the tumour particularly where fibrosis is minimal; here the alveoli bear a very close resemblance to the glomeruli of the normal vagal body. Where fibrosis is at all well-developed the dark cells are found in greater numbers, many nuclei appearing pyknotic (Fig. VII). Mitotic figures are not visible.

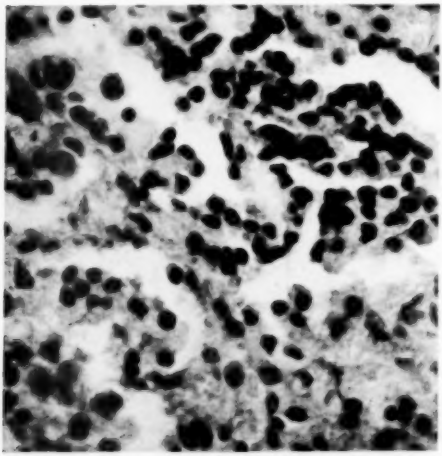

FIG. VI. Photomicrograph at a higher magnification of a section of the afibrous portion of the vagal body tumour. Parts of three glomeruli are shown while both types of cell may be seen. The nuclei on the upper right hand side of the figure are more pyknotic than is usual in the afibrous portions of the tumour. (x 350)

Unfortunately the material available for further histological analysis is small in amount, is formalin fixed, and is, in large part, composed of fibrous tissue. It has been our experience (Birrell, 1952; Willis and Birrell) that where fibrosis is gross then nervous tissue in this type of "tumour" is either completely absent or minimal in quantity. Using Willis's (1945) stain for nerve it has been possible to demonstrate a few indefinite fibres but certainly nothing approaching the extensive innervation of the normal vagal body. A few nerve trunks also can be seen but one cannot dismiss the possibility of inclusion. Both Stout (1935) and Lattes (1950) were able to demonstrate in their tumours an extensive amount of nervous tissue which is probably more than would be accounted for by inclusion.

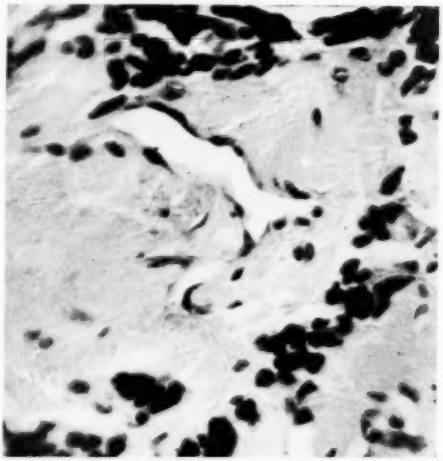

FIG. VII. Photomicrograph of a section of the vagal body tumour showing gross fibrosis with disruption of glomerular structure and bizarre cellular appearance. The sinusoid-like vessel is patent and shows an intact endothelial lining. (x 350)

DISCUSSION

As far as can be ascertained the present case is the fourth example of a vagal body tumour to be described, since Lattes' (1950) first case is the same one as that described by Stout (1935). The main features of the cases so far recorded, including the present one, are summarized in the table. However, as Lattes points out (he also refers to an unpublished case in Canada) other tumours of a similar character and site have probably been reported but under such names that seeking them would be a difficult and possibly thankless task.

The site of origin of these tumours may be considered to be the vagal body for the following reasons:

1. They are always located immediately beneath the jugular foramen and in at least 2 cases the vagus nerve has been obviously incorporated in the tumour.

2. There is consistently present in and around the *ganglion nodosum* of the vagus nerve a small but somewhat diffuse mass of carotid body-like tissue to which the structure of the tumour bears a very close resemblance.

3. Whatever other nerve lesions these patients show post-operatively they invariably have a recurrent laryngeal nerve palsy on the side from which the tumour was removed.

It is of interest to note that Stout states in his case that the tumour appeared to be in the sheath of the vagus nerve; in the few *vagi* which the writer has sectioned most or all of the vagal body tissue has been situated directly beneath the perineurium.

Nevertheless, the general close histological resemblance of the tumour to the normal vagal body in conjunction with the tumour's encapsulation, paucity of mitoses and apparent benign clinical course are sufficient to make one cautious of accepting any claims of neoplasia.

Lattes' (1950) second case would appear to have been malignant, but he notes that a portion of this tumour was almost certainly left behind so that recurrence is not unexpected. "Invasion" of bone, as occurred in Lattes' case, and compression of the brain stem are not criteria for true malignancy when one considers that a simple lipoma will erode bone during its growth, should that bone be directly in apposition with it.

TABLE 1

TABULAR SUMMARY OF RELEVANT DETAILS OF RECORDED VAGAL BODY TUMOURS

Author	Sex	Age	Presenting Symptom and Duration	Treatment	Result	Remarks
Stout (1935) (Lattes Case 1)	F	52	Dull pain in left side of neck for fourteen months	Excision	Well 19 years later with left recurrent laryngeal nerve palsy and Horner's syndrome	Tumour 2.5 x 3 cm.; it lay in the sheath of the vagus and extended up to the jugular bulb
Lattes (1950) Case 2	F	38	Swelling at right angle of jaw for 8 years with recent atrophy of right shoulder and right side of tongue	(1) Exploratory operation (2) Radical removal 5 months later. Some tumour left in jugular bulb	Death 32 months after operation from broncho-pneumonia and pressure on brain stem from recurrent tumour	Tumour 3 x 2 x 1.5 cm.; continuous with vagus nerve. Recurred at jugular bulb and then grew into cranium resulting in compression of brain stem. Left carotid body tumour present
Lattes (1950) Case 4	M	35	Mass in right side of neck for several years	Exploratory operation and biopsy only; considered inoperable. Given deep therapy	Died 5 months later from poliomyelitis; no symptoms referable to tumour	Tumour 5 x 2 x 1.5 cm.; continuous with vagus nerve but not extending into skull. Right carotid body tumour present and also aortic body tumour present
Present Case	F	37	Mass in right side of neck for 10 years	Excision	Well 2½ years later; has right recurrent laryngeal nerve palsy	Tumour 5 x 3.5 cm.: fused with vagus nerve and attached to base of skull

While perhaps too few examples have been described to allow of a definite statement as to the pathological status of this tumour, one feels that it must be regarded as comparable with the carotid body tumour, that is to say, as a hyperplasia (Chase, 1933; Birrell, 1952). Both Lattes and Stout have demonstrated a considerable number of nerves in their histological material including fine non-medullated fibrils. It was not possible to attempt to demonstrate a nerve plexus similar to that seen in the normal vagal body in the present material for two reasons. First, gross fibrosis—a phenomenon long recognized in carotid body tumours—

while secondly, unhappily, the fixation was not satisfactory for silver preparations. A few nerve fibres and trunks could be demonstrated but they were not sufficiently well-preserved to allow neurological analysis.

A curious feature of two of Lattes' cases is the presence of multiple tumours of chemoreceptor bodies, his fourth case possessing not only a vagal body tumour and a true carotid body tumour but also an aortic body tumour which, from its description, probably arose from Palme's *paraganglion supracardiali inferius.*

The symptomatology of the vagal body tumour is usually that of a swelling in the neck behind the angle of the mandible which may be associated with a sensation of a "lump in the throat." In later stages pressure effects on the immediately adjacent

nerves make their presence felt, the hypoglossal and accessory nerves as well as the sympathetic trunk commonly being affected.

The clinical diagnosis is well-nigh impossible when one considers the number and variety of different conditions which may present as a swelling in the neck, more particularly in that the vagal body tumour is a rarety. In the present case a parotid salivary gland tumour was suspected preoperatively. The diagnosis may be suspected at operation but is only clinched by histological examination.

The treatment undoubtedly is surgical excision from which, if complete, a good prognosis can reasonably be expected. A recurrent laryngeal nerve palsy is a natural concomitant of the operation of removal, but other dangers of removal are possible damage to the hypoglossal nerve and the sympathetic trunk as well as the ever present danger in this area of tearing the internal jugular vein. The site of origin of this tumour is one in which it is difficult to obtain a good exposure and the surgeon considers that, in any similar case in the future, he would remove portion of the mastoid process to allow better exposure.

SUMMARY

1. A case of vagal body tumour is described. It is classified as a hyperplasia affecting a small mass of tissue closely resembling the carotid body in its structure and situated in or near the *ganglion nodosum* of the vagus nerve.
2. The normal vagal body has been investigated and its structure and, in particular, its innervation shown to be similar to that of the carotid body.
3. The vagal body is grouped with the carotid body and similar masses of tissue as chemo-receptor bodies which are not considered to have any relation to the chromaffin system.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to Dr. W. G. D. Upjohn (who operated on this patient) and Dr. W. M. Davies, of Colac, for providing notes of clinical details on which the report is based. I wish to thank Dr. G. G. Harkness for the material used in the histological examination. The nerve preparations are the work of Mr. A. G. Willis, M.Sc., of the Department of Zoology in the University of Melbourne.

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THE SURGICAL PATHOLOGY OF CARCINOMA OF THE LUNG

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INTRODUCTION

MUCH is known of the nature of carcinoma of the lung both clinically and pathologically. Its incidence, way of presentation, clinical course, and the variations in final autopsy patterns, are all well recognized.

It is fair to say that for four-fifths of patients discovered to have carcinoma of the lung, treatment at present is palliative, designed to ease suffering and allow them to die decently. In only one-fifth is surgical treatment possible. These statements are substantiated by findings in 1,800 cases of lung cancer treated at the North Regional Chest Surgery Centre, Shotley Bridge Hospital, Newcastle-upon-Tyne. Of these 1,800 patients 45 per cent. had an operation. In 26 per cent. the growth proved irremovable; in 19 per cent., or almost a fifth, resection was performed (Borrie, 1952).

Although deep X-ray therapy has been tried, it cannot yet do more than relieve some patients of uncomfortable symptoms, or more rarely apparently effect a cure. No radiotherapist can yet say which patient will respond to his treatment, and it is doubtful if any surgeon can yet make such claims.

Over the past twenty years the surgical world has resolutely attacked the problem, bent on "curing by excising," at the same time hoping that isolated neoplasms, when widely removed, should not recur, and assuming that surgery of carcinoma is essentially surgery of the lymphatic system. Though most pathologists have been sceptical of these *dicta*, nevertheless these *dicta* have had to be the rocks on which many apparently successful procedures have been built. Yet one asks—How far can they be applied to carcinoma of the lung? In seeking an answer it is proposed briefly:

(a) to review the pathology of carcinoma of the lung,

(b) to dwell on methods of spread, and

(c) to discuss limits of operability.

PATHOLOGY

Bronchial carcinoma is now the commonest cancer affecting males in England and Wales. In the quarter century between 1922 and 1947, the annual number of deaths recorded increased almost 15 times, from 612 to 9,287 (Doll and Hill, 1950). This remarkable increase is out of all proportion to the increase of population, both in total, and particularly in the older age groups. Stocks (1947), using standardized death rates to allow for these population changes, shows that whereas between 1901 and 1920 the rate per 100,000 was of the order males 1.1 and females 0.7, between 1936 and 1939 it had risen to 10.6 for males and 2.5 for females. By its increasing incidence it commands attention.

Bronchial carcinoma is predominantly a disease of males, as all published reports show.

Mason (1949), in reviewing the first 1,000 cases seen at Shotley Bridge, found that males made up just over 90 per cent. of the total. Their ages ranged from 16 years to over 70 years, with highest incidence (37.6 per cent.) in the 50-60 period.

The cause of bronchial carcinoma is still unknown. The subject will not be reviewed here, but notable papers include those of Wynder and Graham (1950), Kennaway and Kennaway (1947), and Doll and Hill (1950).

These growths, arising from bronchial epithelium in either the large or smaller segmental bronchi, have three main histological patterns:

(a) epidermoid or squamous cell carcinoma,

(b) adenocarcinoma, and

(c) undifferentiated carcinoma including oat-, round- and small-cell types.

It is recognized that these divisions are purely arbitrary, that there is a wide range of differentiation possible in one type of carcinoma and great pleomorphism within one tumour. It is felt, nevertheless, that these three groups show the essential histological features and that greater subdivision is neither indicated nor necessary. Dr. Dawson, of the Pathological Research Laboratory, Royal College of Physicians, Edinburgh, who examined all the Shotley Bridge material, on which this paper is based, holds this view.

In Mason's (1949) series the proportions were:

Undifferentiated	36.1 per cent.
Epidermoid	35.2 per cent.
Adenocarcinoma	7.3 per cent.
Unverified	21.4 per cent.

In a series of 200 lung resections of the same material — all examined microscopically—the writer found there were:—

68 per cent. epidermoid carcinoma,

27.5 per cent. undifferentiated carcinoma, and

4.5 per cent. adenocarcinoma.

It is obvious that far more epidermoid than undifferentiated growths can be resected.

The distribution of the growths throughout the lobes of the lungs is shown in Simon's (1937) series of 2,177 cases. The right lung was affected in 1,147, the left in 992, and both in 38 cases. The lobar distribution of 649 of these was:—

Right upper lobe	— 169
Right middle lobe	— 70
Right lower lobe	— 119
Left upper lobe	— 179
Left lower lobe	— 112

MACROSCOPIC APPEARANCE

The macroscopic appearance of lung cancer varies greatly, and includes—

(1) growths fungating into the lumen of the large bronchus,

(2) growths infiltrating round the bronchial wall,

(3) large circumscribed tumours,

(4) small peripheral growths,

(5) neoplastic abscesses.

The macroscopic shapes and appearances themselves matter little. The effect of the growth on lung structure and lung function, and the actual and detectable extent of spread when the patient is first examined are all important to the surgeon.

Depending on its site of origin and extent of spread, so carcinoma of the lung gives rise to various pathological and clinical patterns.

1. *The Blocked Bronchus Pattern*

This is the commonest. The growth, arising from bronchial mucosa, may lie in the main bronchus, or major lobar bronchus, or in one of its segmental terminations. By encroaching on the bronchial lumen, it acts as a foreign body and causes cough and sputum. If the surface of the lesion becomes eroded, the sputum may be blood-streaked. As it develops there comes a stage of "relative emphysema" where air can more readily be inhaled past the growth than exhaled. Such emphysema causes a "tightness" of the chest and difficulty in breathing which is often erroneously diagnosed as "influenza." Rarely, the emphysema may be sufficiently acute to cause spontaneous pneumothorax, which the writer has seen as the first sign of carcinoma of the lung. When the growth finally blocks the bronchus, the lung behind collapses, the size of the collapsed segment depending on the site of the block. The distressing emphysema is relieved; but behind the block is an area of stasis, with stasis hunts infection, and, with retention of infected secretion, the symptoms of general infection are added to the clinical picture.

Many of the bronchi dilate and become bronchiectatic.

The collapsed lung parenchyma may become congested, and in it may develop single or multiple abscesses. Pleurisy develops over this area of affected lung, and may either be associated with an effusion that can become an empyema, or else parietal and visceral layers may firmly adhere and thicken.

It is well recognized that "influenza," "pneumonia," "lung abscess," or "empyema" must primarily be regarded as signs of underlying lung disease, and that no investigation of patients so affected has begun until both chest radiography and bronchoscopy have been completed.

The cough and blood-streaked sputum, the discomfort of transient emphysema, and the pleural pain secondary to infection are usually sufficient to make a patient seek medical advice, and none of these symptoms denotes inoperability of the growth.

2. *Solitary Tumour Pattern*

Tumours growing into the lung parenchyma may silently enlarge until discovered by chance X-ray examination or until sufficiently large to produce some part of the blocked bronchus syndrome. As will be shown later, this solid round focus even though peripherally placed, may be associated with extensive lymph node or blood stream invasion.

3. *Neoplastic Lung Abscess Pattern*

A neoplastic lung abscess may arise in one of three ways. It may occur from infection in the lung parenchyma secondary to a blocked bronchus. It may be due to a solitary tumour cavitating centrally in which variety the abscess wall usually varies greatly in thickness. It may arise from endobronchial spill of infected sputum or pus from the tumour. The resulting abscess can arise near the tumour, or even in the other lung.

With rest and posture such abscesses have been observed to get smaller. Brock (1952) reported that in 477 cases of lung abscess, 83 or 17.5 per cent. were due to a bronchial carcinoma.

Nevertheless, the likelihood of a lung abscess in a middle-aged man being neoplastic must clearly be recognized, and his only chance of cure by operation must not be needlessly jeopardized by indefinite watching and ineffective chemotherapy.

In discussing methods of spread of cancer of the lung one also bears in mind the

4. *Clinical Pattern Associated with Direct Spread of Cancer of Lung*

This varies with the sites of the primary and secondary growths.

Some peripheral growths first appear as tumours on the chest wall. Others, where the pleural layers are not adherent, seed themselves under the pleura, and cause a large effusion. If complete aspiration and further chest X-ray do not reveal multiple peripheral shadows, the histo-pathology of this type is best established by direct pleural biopsy, either through a thoracoscope or by resecting a segment of rib. Rib erosion is detected by penetrating X-rays.

Superior vena caval obstruction occurring almost invariably from growths in the right upper lobe denotes inoperability either by direct invasion of the cava, or by invasion of lymph nodes surrounding the vena cava.

Paralysis of the left vocal cord means similar invasion of left recurrent laryngeal nerve and not infrequently also fungation into the left side of trachea or oesophagus.

The Pancoast syndrome associated with cancer of the lung usually means invasion of nerves and mediastinal tissue at the root of the neck.

Direct metastases into the mediastinum are generally more readily detectable when situated proximal to the hilum of the lung than below the level, as this region is more accessible to examination by both bronchoscopy and oesophagoscopy.

Barium swallow is of use in suggesting direct invasion of the lower oesophagus, but barium swallow evidence, unbacked by biopsy proof of penetration into the oesophagus, cannot alone be accepted as evidence of direct invasion, and must not be used as a sole sign of inoperability. Doubtful cases are best explored.

5. Distant Metastases Pattern

Not infrequently distant metastases, cutaneous lumps, an enlarged liver, brain tumour, etc., are the first presenting signs of carcinoma of lung, and the size of the secondary growth may greatly surpass the primary.

METHODS OF SPREAD

Lymph Node Metastases

Lymph vessels from each lung not only converge on the bifurcation of the trachea, but also communicate with the posterior mediastinal lymphatic vessels along the path of the inferior pulmonary veins and through the pulmonary ligaments. The path to the mediastinum is therefore broad.

Peripheral growths which invade the chest wall will invade the axillary lymph nodes. Both mediastinal and axillary invasion will in time affect the supraclavicular nodes, not always, it must be noted, on the same side as the lung lesion. It is not uncommon to find a patient with a right supraclavicular lymph node metastases from a left lower lobe growth.

Apart from general considerations, to be discussed later, the detection of metastases is all important in assessing operability.

In thinking of lymph node metastases, however, it should be appreciated that there are many other problems requiring an answer.

The following questions logically arise:—

What are

(a) the anatomical sites of the intrapulmonary lymph nodes,

(b) the usual path of lymphatic spread of carcinoma of lung from the various lobes towards the hilum,

(c) the nature and extent of pulmonary lymph node invasion at the time of operation,

(d) the behaviour of the various histological types of carcinoma of lung in their regional lymph nodes, and

(e) the relationship of invasion of neoplasm of the lymph nodes of the operation specimen to prognosis?

(f) What is the relationship between symptomless carcinoma of lung first detected by mass radiography, extent of lymph node invasion at the time of operation, and survival?

To find answers to these questions the lymph nodes of 200 specimens of lungs removed by operation for carcinoma of lung were carefully dissected, the sites of each lymph node charted on a drawing of each lung, the nodes individually examined, and the charts completed when Dr. Dawson's pathological report was to hand. This work can well be criticized in so far as three representative sections at the most were made through each lymph node, leaving a vast volume unsectioned. As, however, it is not at present economically possible to section, let alone examine, every cell layer in even one lymph node, the work is presented as it was done, and must be judged in that light. Similar difficulties and criticisms apply to related work on carcinoma of the rectum, breast and stomach.

The details have been described elsewhere (Borrie, 1952) and only summarized findings will be presented here.

Anatomically the lymph nodes of the right lung were found to be grouped round the segmental bronchi, the commonest site being between the upper and middle lobe bronchi, and the next commonest site along the medial surface of the right main bronchus.

The lymph nodes of the left lung were similarly disposed around the base of the segmental bronchi, the most frequent site being in the angle between upper and lower lobe bronchi, and thereafter along the medial surface of the main bronchus.

Pathologically the usual path of lymphatic spread of carcinoma of lung from the various lobes, and the nature and extent of pulmonary lymph node invasion at the time of operation can only adequately be appreciated by study of all the charts, but composite diagrams summarize the picture. Lymph nodes were invaded in approximately half of the specimens resected.

From a study of these charts it is concluded:—

(1) That the regional nodes of each lobe lie around the base of the segmental bronchi.

(2) That in the right lung neoplastic invasion does appear to progress from one lymph node barrier to the next, and that the most frequently invaded groups are:

(a) those lying between the right upper and middle lobes, and

(b) medial to the right main bronchus.

(3) That in the left lung the progress of spread is similar, the most frequently invaded group of nodes being those lying:

(a) between the left upper and left lower lobes, and

(b) medial to the left main bronchus.

This is not surprising, for these are the sites where intra-pulmonary nodes were most commonly found.

(4) Further, these findings emphasize the importance of that region between the upper and middle lobes on the right side, and between the upper and lower lobes on the left side, and show why lobectomy, even as a palliative procedure for carcinoma of lung, is frequently not technically possible.

The behaviour of the histological types of carcinoma of lung in the pulmonary lymph nodes was investigated:—

The summarized findings were that, whereas epidermoid growths are by far the commonest group resected, comprising 68 per cent. of this series, they had only a 42.5 per cent. invasion rate of the lymph nodes. On the other hand undifferentiated growths, comprising only 27.5 per cent. of this series, had a 70 per cent. lymph node invasion rate. It is therefore suggested that, apart from any other characteristic of the undifferentiated type of growth, this greater invasion rate of lymph nodes is one of the factors in its worse prognosis.

In a survey of the problem "Can a knowledge of extent of invasion of the lymph nodes of the operation specimen reasonably be used in assessing prognosis?" the following conclusions were reached. They were based on study of 70 resections completed more than three years before this investigation was undertaken.

(1) That having survived operation, by the end of three years a fifth of the patients were alive.

(2) That there is a distinct difference between the behaviour of the undifferentiated and epidermoid cell carcinoma, 71 per cent. of the former, and 30.5 per cent. of the latter being dead from metastases one year after operation. Few, if any, undifferentiated growths survive three years. On the other hand, 26 per cent. of epidermoid growths may survive beyond three years.

(3) That, as 85 per cent. of cases with lymph nodes invaded, and 66 per cent. of cases with no lymph nodes invaded were dead three years after operation, there is, as yet, no clear relation between presence or absence of lymph node invasion, and long term survival, except that invasion of lymph nodes adversely affects prognosis and usually means death within three years of operation.

(4) That there was no significant prognostic factor between type of growth in the invaded lymph nodes and survival time.

(5) That the number of nodes invaded per specimen was no clear guide to prognosis.

(6) That it is not possible to divide carcinomas of lung into 3 grades according to site of invaded nodes as a basis of prognosis, for too high a proportion of patients with no nodes invaded died early from blood-borne metastases, to allow of such a claim.

(7) That invasion of mediastinal nodes was usually associated with death within fifteen months of resection.

(8) That upper lobe growths had a small, if not significantly more favourable prognosis.

Symptomless Carcinoma of Lung Detected by Mass Radiography, Extent of Lymphatic Spread at Operation, and Survival Time

Eight of the 200 patients were symptomless. Their carcinomata were first detected when mass radiography revealed an unsuspected shadow in the lung fields.

The growths were situated:

Right middle lobe	1
Right lower lobe	2
Left upper lobe	3
Left lower lobe	2

In only 2 patients were biopsies positive. In the remaining 6, resection was done for a symptomless round shadow, which, in the absence of any other cause, was believed to be primary carcinoma. Six patients had pneumonectomy, and two lobectomy performed.

Subsequent examination of the specimen showed that in 3 of the 8 cases, hilar lymph nodes were invaded. Two of these patients are dead seven and eight months after operation, and the third is alive eighteen months from operation.

The final outcome is not surprising, for, where several lymph nodes are invaded at the time of resection, death is likely within a year of operation. On the other hand, it is again emphasized that, with one node invaded, or more, no assurance for the future can be given.

Three patients had no lymph nodes invaded, yet lived but a short time after operation, dying from metastases, three, nine and nineteen and one-half months respectively.

Two others—one a lobectomy, and one a pneumonectomy—are still alive, both sixteen months after operation. Neither had lymph node invasion.

In thinking about this group, it does seem remarkable that such peripheral neoplasms, first detected as a round shadow on an X-ray film, can have spread into the lymph nodes so soon. And yet, the fact that such does happen, only emphasizes the more that situation of primary growth in the lung alone confers no immunity and no security against early lymph node invasion, and that, because these peripheral growths do not readily cause the blocked bronchus syndrome, they are often far advanced when first detected.

Again, early death from distant metastases, without lymph node invasion in this group of peripheral neoplasms only emphasizes the more the importance of early blood-stream spread, and of the unpredictable nature of primary lung cancer, following operation.

Blood-stream Metastases

Blood-stream spread will be discussed only in relation to pneumonectomy. The distant spread, to brain, liver, kidney, suprarenal gland, bone and skin is too well-known to call for further comment.

In the series of 70 resections done more than three years before the review, twenty of the patients who died within fifteen months of operation from metastases, were found to have no lymph node invasion in the nodes of the specimen at all. Further dissection of these specimens showed that the growths had either penetrated deeply into the walls of the veins around which they grew, or had even fungated into the lumen of the veins.

Further light is shed by asking the question, "Did any of the patients who had resection, and who died after operation, have any evidence of distant metastases found at necropsy—metastases which were not detected in the pre-operative assessment?" Four of the 28 patients had such undetected macroscopic metastases. All 4 had epidermoid cell growths, and in all 4 the unsuspected metastases were in the suprarenal glands.

Clearly blood-stream invasion occurs much earlier and more easily in lung cancers than is usually appreciated, and absence of lymph node invasion in no way indicates immunity from blood-stream spread.

Alwyn (1951), who reported two cases of massive malignant emboli occurring during pneumonectomy, and who suggested that there are grounds for believing smaller ones frequently occur but pass unrecognized, has advocated that contamination of the general

circulation by tumour emboli be anticipated by tying the veins within the pericardium before manipulating the tumour.

Advisable though such action be, it is but a small part of the story. The phenomenon of early blood-stream invasion is an inherent characteristic of the disease.

WHAT ARE THE LIMITS OF OPERABILITY

These depend on clinical, radiological, bronchoscopy and operative findings.

Exploratory thoracotomy is recommended in all cases without contra-indications, such as clinical or radiological evidence of dissemination of growth, bronchoscopic evidence of extension of the growth too close to the carina and into the mediastinal viscera, as well as distortion and widening of the carina. It is admittedly possible to resect carinal growths, especially using Carlens' double lumen endobronchial catheter and performing tracheal grafts; but, as the carina itself lies so deeply in the mediastinum, the chances of growth having disseminated far beyond the scope of operation are too great to warrant such extensive procedures as a routine.

Age is certainly a factor, but it is interesting to note that, whereas in the Shotley Bridge series no successful pneumonectomy had been performed for cancer of lung on a man over 67 years of age, in three consecutive successful pneumonectomies at Green Lane Hospital, Auckland, this year, the ages were 70, 70 and 71. One earlier patient was aged 73 years.

Poor cardio-respiratory reserve, emphysema and arteriosclerosis have been shown to be contra-indications. The extent to which differential lung function studies and cardiac catheterization with or without angiography will influence the decision to operate in doubtful cases, is still under review.

Although I have not yet found an operable growth in the presence of superior vena caval obstruction or recurrent nerve palsy, diaphragmatic palsy does not conclusively indicate malignant invasion of the phrenic nerve which may be injured by pressure alone, or by associated inflammation.

Radiologically, one should never condemn growths as inoperable because of the extent of X-ray shadowing. This may indicate a space occupying lesion—but as often as not —merely a collapsed or congested lobe or lung from a central neoplasm.

The findings at thoracotomy are the key to the operative procedure to be chosen. Essentially the problem is mechanical—can the growth be freed, and the hilum approached.

For growths adherent to ribs, occasionally, localized resection of the chest wall is successful.

Pleural fluid, as with empyema, is no bar to operation when it is merely the result of the blocking of a bronchus, and not the result of local neoplastic dissemination.

Portions of diaphragm can readily be resected if required. Intra-pericardial approach to the pulmonary veins originally advocated by Allison (1946) has been extended, and when combined with a mediastinal block dissection, can give a formidable local clearance of tissue.

Patients who have pneumonectomy in the presence of lymph node invasion, as has been shown, are unlikely to be cured of their disease; and by and large, mediastinal lymph node invasion must be accepted as a sign of inoperability.

Thereafter the chief problems are the feasibility of dividing an artery, two veins and a bronchus, and achieving sound healing.

Palliative Resection

The very real problem of palliative resection will not be discussed here.

In summing up, it can be said that, though the pathological processes certainly do not favour the patients' chance of subsequent "cure," nevertheless a few are apparently "cured," or relieved for a time of symptoms; that better results may yet be obtained by pre-operative deep X-ray therapy; and that this surgical experiment still requires further trial and at least another ten years of work before anything like firm conclusions can be drawn.

SUMMARY

In considering the surgical pathology of carcinoma of lung, the macroscopic shapes and appearances of growths are of little significance. The effect of the growth on lung structure and lung function, and the actual and detectable extent of spread when the patient is first examined are all important to the surgeon.

Five clinical patterns have been described, namely that of the "Blocked bronchus;" "the Solitary Tumour;" "Neoplastic Lung Abscess;" "Direct local spread," and "Distant spread." The intra-pulmonary sites of lymph nodes are shown. The methods of spread by lymph nodes are described in the light of the findings of dissection and microscopic examination of the lymph nodes of 200 specimens resected at operation.

In discussing "symptomless carcinoma of lung detected by mass radiography," "extent of lymphatic spread at operation" and "survival time," it is stressed that situation of the primary in the lung alone confers no immunity and no security against early lymph node invasion. Because these peripheral growths do not readily cause the blocked bronchus syndrome they are often far advanced when first detected. The absence of lymph node invasion in no way indicates immunity from blood-stream spread.

Finally the limits of operability are discussed.

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THE VALUE OF EXPOSURE IN LOCAL BURNS THERAPY

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THIS is not an attempt to convince surgeons that exposure is the only method of burns therapy. There is no single method which is applicable to all cases. However, there are basic problems to be faced in the local therapy which must be understood before different methods can be compared or criticized. The theory and technique of the exposure method will be described, because it is felt that many Australian doctors are as yet unfamiliar with this method. At the same time it is realized that the aphorism stating "the best dressing is no dressing" is an old one. Recent developments have been in understanding and developing the finer points in its practice. The result is a powerful weapon which will save much suffering and financial difficulty in the event of a major disaster.

Theory of Exposure

By a burn is meant a thermal injury of skin. The degree of epithelial destruction is determined at the time of initial injury. The familiar clinical features of redness, swelling and exudation are manifestations of the widespread inflammatory changes in the local circulation. The aim in therapy is to restore epithelial cover to the area and to minimize the local circulatory changes of inflammation. In deep burns, i.e., whole skin thickness, this is achieved by early skin-grafting. In superficial burns one must prevent further injury to the remaining epithelium. Bacterial infection is the commonest damaging agent to the epithelial remnants and also sustains the local circulatory changes of inflammation. Control of sepsis is therefore the main weapon necessary to obtain early healing and it is in this way that the exposure method is of most assistance.

Exposure is the simplest means we have of rendering the burned surface unsuitable for bacterial growth and invasion. The early serous exudate dries out and forms a continuous eschar over the injured area. This dry, solid surface is at room temperature and receives a high incidence of daylight. Most bacteria require moisture, warmth and darkness for satisfactory growth and so fail to establish themselves on the burn eschar.

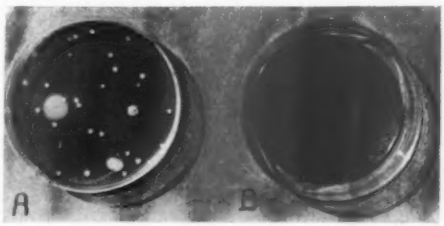

FIG. I. Photograph of two nutrient agar plates which were exposed in a surgical ward at the same time. After fifteen minutes, plate A was placed in incubator and after thirty-six hours shows numerous bacterial colonies. Plate B was left throughout exposed in the ward. The agar has dried and shrunken but no bacterial colony has grown.

A simple experiment illustrating concisely the principle of the exposure method of burns therapy is as follows. Two nutrient agar plates are exposed together in a ward. After a short time, fifteen to thirty minutes, one plate is removed and placed in the incubator. The other plate is left uncovered in the room. After thirty-six to forty-eight hours, if the two plates are compared, a great difference will be seen (Fig. I). The plate which has been incubated shows many colonies of bacteria and fungi actively growing. The plate left exposed throughout in the ward has no colonies visible; the nutrient agar has become dry and has shrunken away from the margin of the Petri dish. The conclusion is that the conditions of exposure are inimical to bacterial growth. The factors concerned must be the altered state of the nutrient medium from drying out and the absence of the darkness and warmth suitable for bacterial growth which are provided in the incubator.

The same course is seen in burns treated by the "open" and "closed" methods. Under a pressure dressing the burn surface has a similar physical environment to the culture plate in the incubator—warmth, moisture and darkness—and the same sequence of free bacterial growth and suppuration results. Once the eschar has formed on an open burn it remains clean and dry. Swabs from this eschar have been found in some cases to grow pathogenic organisms, including *Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli* or *Pseudomonas pyocyaneus*. The absence of suppuration in these cases despite the arrival of pathogenic organisms on the eschar strongly supports the open technique.

To those handling these patients there is a refreshing freedom from that offensive odour so often encountered with burns treated by closed methods. Pus is absent. Pain also is absent after the first day or two and there is not the repeated ordeal of daily dressings.

With the freedom from suppuration and pain the general condition of the patient rapidly improves. This is reflected in the temperature chart and in his appetite and morale.

Cross-infection of wounds, so great a problem during the dressing of burns, ceases to be important. After the formation of a firm, dry, intact eschar there is little danger of infection occurring. Organisms may land on the eschar but do not establish themselves. This aspect of the exposure method would be of assistance to those concerned with accommodating mass burn casualties at any future date.

TECHNIQUE OF EXPOSURE

Leaving aside those problems arising during the evacuation of battle casualties and the resuscitation of the severely burned, we shall consider the local measures to be adopted.

The initial burns toilet is performed in the operating theatre with the usual aseptic precautions. In only a few cases is general anaesthesia necessary. After a pre-operative hypodermic injection of omnopon gr. $\frac{1}{3}$ and scopolamine gr. 1/150, the intravenous administration of pethidine is usually satisfactory. Given in doses of 50 mgm., a total of 100 or 150 mgm. pethidine will cover the half-hour or so of the toilet.

Cetavlon is used to cleanse the area. Blisters are snipped and raised skin excised. In the case of phosphorus burns a 5 per cent. solution of copper sulphate is applied in soaks to the areas involved. Instead of the application of absorbent pressure dressings at this stage, the patient is returned to the ward with only a single layer of gauze soaked in saline draped loosely over the burned areas. A sterile towel covers the area during transfer back to the ward.

In the ward the patient is received on to a warmed bed provided with a sterile or fresh sheet. The towel and saline gauze, used as a protection during the return from the theatre, are removed. Some surgeons apply a light dusting of penicillin in lactose powder. This is not essential because the systemic administration of penicillin produces a locally effective concentration in the exudate. However, the drying action of the powder might be useful when exudation is heavy. It has been found that an electric fan played on or near the part assists drying of the exudate when this is copious and in the hot, humid weather encountered for a time in Japan.

Where possible, the burned part is elevated on pillows or by raising the end of the bed on blocks. These simple measures have minimized oedema and exudation. Pressure dressings with elastic bandages are not necessary to achieve this end.

To facilitate the formation of a continuous intact eschar over the area this must be immobilized. For the most part the stinging pain in recent burns discourages movement. It is in this early phase that the correct posture of joints and of the hand in particular must be supervised.

A firm, dry, continuous eschar will be present within 48 hours in most cases. This serves as a protection to the epithelium remaining deep to it and the eschar is left undisturbed. When the burn is superficial the eschar shrinks and separates in ten to fourteen days, leaving the new intact skin surface. When the burn has involved the

whole depth of skin, separation is much slower (Fig. II) and will only follow sloughing of the necrotic area. In the absence of sepsis this might take up to five or six weeks. Therefore, the practice is to regard all areas as full thickness where the eschar has not separated in three weeks. At the end of the third week or earlier if there is no doubt that an area is a full-thickness burn, the patient is anaesthetized and the crust is removed in the operating theatre. Much of the surface beneath the eschar may be epithelialized but the adherent parts leave granulating or freely bleeding areas after excision. In many cases immediate split skin grafting directly on to these areas has been successful. In some cases excision of deep burns is possibly not complete or unsuspected suppuration may be present beneath a crust. Then the excised surface is dressed with *tulle gras*, absorbent gauze and wool for twenty-four to forty-eight hours and reviewed again for grafting or further excision. It must be stressed that granulating surfaces cannot be exposed, for attempts at this will lead to distrust of the method.

is instituted. This was common in those cases evacuated from Korea where the conditions of wounding make contamination almost universal. Pulaski (1951) advocates exposure only when the case arrives within seven days, but we have sometimes exceeded this limit without ill-effect. Removal of large areas of eschar may be necessary in the first days of exposure of these mildly infected burns. This is facilitated by soaking for a few hours with saline. Drying soon follows removal of an infected eschar.

To expose the extremities elaborate orthopaedic appliances are not necessary. Commonsense, care and interested nursing are essential. The linen of the bed requires to be changed at least twice daily in the first four or five days of exposure therapy, but need not be sterile. A cradle holding a sheet over the exposed area has been necessary during ward cleaning and sometimes at night in cold weather. On the whole the room temperature need not be controlled unless approaching 60°F and the main factor for comfort is the avoidance of draughts. The cold winter weather of Korea is adequately

FIG. II. (A) Petrol burns of both legs with dry eschar beginning to separate after twelve days. (B) At three weeks the eschar on the right leg had not separated and was excised. The area of skin loss was covered with split skin grafts.

Another dangerous misconception is that once the area is exposed the active treatment has ceased for the time being. On the contrary, the area requires constant supervision. This is to ensure that drying is rapid and complete, to remove any excess crusting as may occur if sepsis is already present and to detect at an early stage any collection of fluid or pus which might be trapped beneath an eschar and require removal of this eschar. These latter problems arise when the burn is already infected before the open therapy

compensated by the use of space-heaters in the wards. Again, in the hot weather, these patients are more comfortable lying in a near naked condition than having a large area of their body surface enclosed in copious dressing.

SPECIAL AREAS

The principle of the method is the same wherever it is used but special problems arising in some parts of the body deserve mention.

Face

Several patients have been seen who were trapped in burning tents. These men exhibited respiratory distress with the physical signs of bronchopneumonia, which in one case was fatal. It is necessary to consider the possibility of such tracheobronchial injury when a patient is seen with facial burns.

FIG. III. Extensive facial burns caused by phosphorus bomb explosion. After five days oedema is subsiding.

The local problems are in the management of the orifices during the stage of swelling and crusting. For the most part gentle saline swabbing will remove crusted serum from the nares, eyes and ears. The eyelids usually become oedematous and close within twelve hours but by the third day there is great improvement (Fig. III). During this period albucid drops are instilled after the cleaning of serum from the fissure. Tarsorraphy is not indicated in those patients with mild ectropion from only superficial burns of the face. With deep periorbital burns tarsorraphy is sometimes necessary and will make excision and grafting of these defects more comfortable.

Neck

The front and sides of the neck are frequently burned at the same time as the face. In the first few hours the patient adopts an attitude of neck flexion with the chin close to the sternum. At first this is to find comfort but soon becomes an established deformity by muscle fixation. If crusting is allowed to occur in this posture there is even less likelihood of correction. Suppuration may occur in those skin folds which are actually not exposed but in which burned skin is opposed to skin. Therefore hyperextension over pillows is encouraged in the first place and crusting obtained in this position (Fig. IV). Subsequently the physiotherapist will be less extended to obtain early and full return of neck movements.

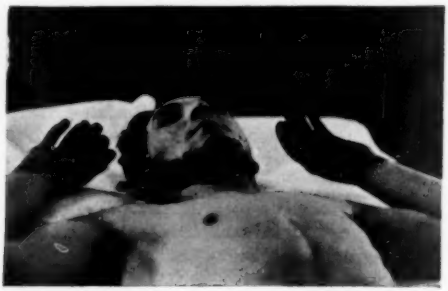

FIG. IV. Petrol burns of neck and hands showing a satisfactory posture in which to obtain crusting.

Arms

Elevation of the arm on pillows limits oedema satisfactorily. Crusting in the region of the joints limits the movements possible until separation of the crusts begins. Provided the burns are superficial so that eschar separation is early, the range of joint movements is soon regained by physiotherapy.

Hand

The main difficulty in this region is to maintain the functional posture of the wrist and finger joints during crusting. The common deformity to find is wrist flexion and metacarpo-phalangeal extension so that crusting occurs in the position of claw-hand. If the burns are superficial an early return of function can be expected as the eschar will separate rapidly. However, with deep burns, excision in the theatre should not be delayed past the third week and joint posture can be corrected then by manipulation and plaster slab fixation. The inability to use saline baths to maintain joint movements in the hand must be regarded as a disadvantage of the open method in this region, particularly with deep burns.

Trunk

Extensive burns of the chest and abdomen are satisfactorily treated by exposure. There is great difficulty, however, in applying this method to circumferential burns. Use has been made of the Stryker bed to facilitate turning of these patients so that drying may occur on both aspects. One finds that some dressing is necessary for the dorsal surface rather than having a patient lying on a crusted surface. The changing of this dressing is facilitated by nursing on the Stryker bed.

With burns of the back of the leg a flexion deformity at the knee is common (Fig. V). This is corrected by physiotherapy if the burns are superficial and the crusts separate early. Prevention of deformity by supervision during the first stage of eschar formation is preferable.

In rehabilitation one must stress to the patient the necessity for wearing elastic bandages over the recently epithelialized leg, particularly if skin-grafting has been necessary. This requires strict supervision by the surgeon and physiotherapist together. Hanging the leg over the side of the bed for increasing periods daily is necessary before walking is allowed. The leg is never allowed to be dependent without elastic support and is inspected for cyanosis and blebbing after each period before this time is extended or walking is permitted. The elastic bandage affords protection against minor trauma as well as circulatory support.

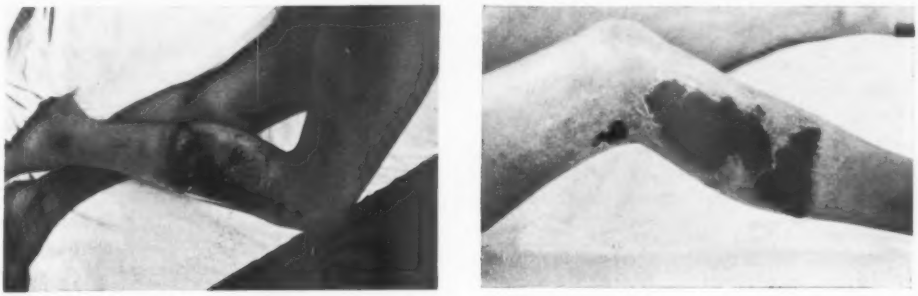

FIG. V. (A) This flexion deformity had become established in two days and was fixed by the crusting of the burn.

(B) Posture improving as crusts separate in third week. Adherent eschar indicates areas of deep burns.

Buttocks and Perineum

The absence of dressings from this region simplifies nursing and decreases sepsis. Adults with buttock burns are nursed prone. With children, Wallace (1951) raises the lower extremities by skin traction from gallows splints until the buttocks are off the bed. Patients encountered with burns of the penis have been satisfactorily nursed with an indwelling Foley catheter.

Legs

This has been the commonest site for burns in this series of military casualties but the foot is rarely involved owing to protection by footwear. Even in circumferential burns of the leg satisfactory crusting can be obtained by resting the foot upon a pillow. However, in the upper third of the thigh, such burns usually require dressings to the posterior aspect at least.

DISCUSSION

A knowledge of what the exposure method of burns therapy has to offer will be of immense value in the event of mass casualties. It has been estimated by Pearse and Payne (1949) that 65 per cent. to 85 per cent. of all casualties from an atomic bomb will have thermal injuries. These will be from two sources. One is the immediate transient flash at the time of explosion which will involve only those exposed surfaces of the

body facing it. The other is the widespread conflagration arising in buildings ignited by the initial flash. The question of treating radiation burns will not arise. The burns casualties will require to be ruthlessly sorted into three groups of which only one will require skilled medical attention. The groups are (a) those so severely burned that there is no hope of saving life; (b) those so mildly burned that treatment can be administered by the casualty himself or a first-aid worker; (c) burns of intermediate degree where skilled treatment, if available, will be able to save life and certainly accelerate healing. The method of local therapy will have to be simple and economical as well as effective. The several advantages of "exposure" over "closed" therapy are:

(1) the absence of supply problems which include the availability of cotton wool or elastic bandages and storage facilities;

(2) no tying-up of staff in performing thousands of dressings and no fixation of dressings in difficult regions;

(3) the area can be inspected rapidly by the surgeon without the usual inconvenience of arranging *rendevoux* with patients in the bath;

(4) comfort is increased in hot climates where copious dressings may upset body temperature regulation.

Apart from the difficulty in exposing circumferential burns of the trunk, the greatest disadvantage of the open method is in transportation. Certainly under field conditions and presumably under civilian disaster conditions the evacuation of burns casualties requires the application of some form of dressing. For this the most satisfactory is a single dry woollen dressing over dry gauze and fixed by gauze bandages. When the site of definitive treatment is reached and the general condition permits it, the burned area can be exposed. Because flash-burn casualties are likely to have one aspect of the body uninjured, Walsh (1951) has strongly advocated the use of exposure.

It should be made clear that there is no difference in the aim of the two methods of local burns therapy. This is the control of sepsis. The difference is in the method adopted to achieve this object. The closed method uses exclusion of bacteria and absorption of exudate by dressings and bacteriostasis by local antibiotics. The open method achieves control of sepsis by drying which renders the burned surface unsuitable for bacterial growth and ignores any organisms arriving on this surface. Realizing that infection will not occur after crusting, the worry of cross-infection, so troublesome in closed burns units and stressed by Colebrook (1950), becomes negligible. This helps to simplify the problem of accommodating mass burns casualties.

The criticism that there is some delay in the separation of deep burns is certainly valid. Separation of slough is normally assisted by infection and since this is absent the delay can be accounted for. But there need be no anxiety if the policy is adopted of surgical excision of deep burns by three weeks. A difficulty in the technique is that removal of the crusts can disturb the thin blue sheet of new epithelium over recently healed areas. This can be avoided with care and experience.

A new technique likely to be of assistance in the local treatment of burns is that of enzymic debridement. Some results of Tryptar therapy have been seen in which separation of sloughs from deep burns has been hastened by local application and injection under the eschar of this pancreatic proteolytic enzyme preparation.

Most advances in therapy arise from a clearer understanding of the main problem which in local burns therapy is the control of sepsis. Exposure has been found to be an efficient method of control. Closed dressings when used with this aim in view can also be effective but are more expensive in material and manpower. The two methods are interchangeable except that granulating surfaces cannot be exposed.

This paper is based on personal experience gained in a Burns Unit established at the British Commonwealth General Hospital at Kure, Japan, and with the Commonwealth Division in Korea. I have been impressed by the high morale of even severely burned men when treated together in a Burns Unit.

The necessity for such units in civil practice is to be stressed. They will provide more efficient treatment for burns casualties, allow the evaluation of new methods of treatment and provide opportunity for training of medical staff, both specialist and general, in the principles of burns therapy.

ACKNOWLEDGEMENTS

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JACOPO BERENGARIO DA CARPI (1470-1530)

By K. F. Russell

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SINCE its foundation in the twelfth century the Medical School of Bologna has played a major part in the history of medicine. During the Renaissance many notable figures worked there and in the anatomical field one of the greatest was Jacopo Berengario.

Berengario graduated at Bologna in 1489 and was appointed lecturer in surgery there in 1502. He devoted much time to the study of anatomy, made a number of significant discoveries, there is considerable evidence that he performed his own dissections and above all he was not a slavish follower of Galen. The anatomical text-book of his period was that of Mundinus, first compiled about 1316 and which appeared in print on a number of occasions in the latter part of the fifteenth century. In 1514 Berengario himself edited an edition of Mundinus which was printed at Bologna and this was to be the forerunner of a number of works by Berengario in which he added commentaries upon the text of Mundinus. These commentaries were, in fact, important original contributions and the works were made more valuable to the student by the addition of illustrations. The first of the books was *Carpi commentaria cum amplissimis additionibus super anatomia Mundini* printed in 1521 at Bologna and this was followed by his *Isagoge breves perlucide ac uberime in anatomiam humani corporis*, 1522. The *Isagoge* proved very popular and subsequently went through a number of editions (Bologna, 1523; Venice, 1523, 1533, 1535; Cologne, 1529; Strassburg, 1530, 1533).

On modern standards both books seem crude but it must be remembered that this is the period before Vesalius and when they appeared they were a great advance on anything that had previously been published. They were the first books to appear with a number of illustrations and this fact alone was important; moreover, these were drawn by a skilled artist. The text showed that Berengario was a careful observer, he gives the first description of the vermiform appendix and, as will be shown later, the first account of horse-shoe kidney. His description of the brain is good and he tells the student how to find the ventricles and the choroid plexus.

Apart from his anatomical eminence Berengario was a surgeon of considerable skill and this skill is shown in a book on fractures of the skull (*Tractatus de fractura calve sive cranei*) which he wrote in 1518. Quite early in his medical career he acted as adviser to the great Medici family, a relationship which lasted throughout his lifetime.

That his books on anatomy were popular is shown by the fact that his *Isagoge* was translated into English nearly 140 years after it had first appeared. This translation was done by Henry Jackson, a Member of the Company of Barber-Surgeons of London, and first appeared in 1660, this being followed by a re-issue in 1664. The 1660 edition is of almost legendary rarity, probably only 3 or 4 copies being in existence. The 1664 edition is almost as rare (probably only about 10 copies exist) and the College is extremely fortunate in having a copy of this issue in its Library where it forms part of the Cowlishaw Collection.

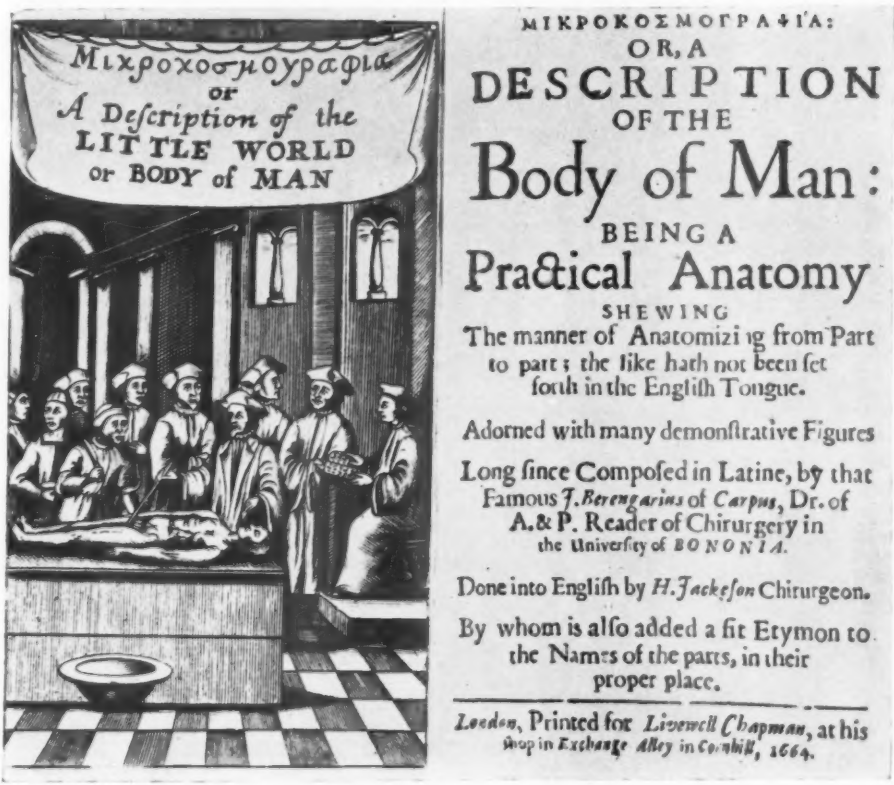

FIG. I. The frontispiece and title of the 1664 edition of Jackson's translation of the *Isagoge*. The College copy shows differences in the type-setting of the title when compared with the British Museum copy, thus indicating that more than one issue of this edition was printed.

As Larkey and Tum Suden (1934) point out, both text and illustrations of the translation are taken from the *Isagoge*, probably from the 1522 edition, but the frontispiece is an adaptation of the one which appeared on the title of the Venice, 1535 edition. The illustrations used by Jackson are very crude copies of the original which give little anatomical detail; in all, there are 25 figures and these are usually on 8 plates but as the figures were printed on large sheets to be cut up afterwards for binding in the book the actual number of plates may vary from copy to copy. This is seen in the College volume where three separate plates appear together on the one sheet.

The only difference between the 1660 and 1664 editions is the title page which was reset for the later issue. Comparison of the title page of the College copy with the title of the 1664 edition in the British Museum (illustrated by Larkey and Tum Suden) show that these are two separate issues, many small differences in the printing being apparent; for example, the translator's name is spelt Jackeson in the College copy but Jackson in the British Museum copy.

The College copy once belonged to Richard Mynors who purchased it on 20th October, 1720, and inscribed on the flyleaf the following sentiments:—

> E Libris Richardi Mynors, Pharmacopola Civitatis Londini. A Freeman of ye Citty of London and studint in Physick. A well wisher of all honist Physitians and skilfull Chyrurgians and good Apothicaries.

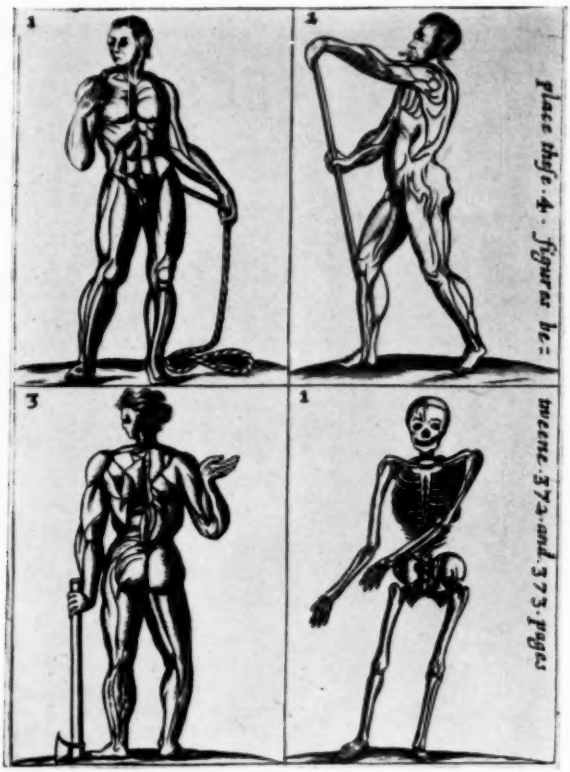

FIG. II. One of the plates showing the superficial muscles and a skeleton. They are crude copies of the original.

Berengario gave the first description of horse-shoe kidney and this is included here as translated by Jackson. The extract will give an idea of the style of the translator.

> I my self also in the year 1521 in our exercise at Bononia, saw in one publiquely Anatomised, one of the Emulgent arteries that made one Pore in the right side without the kidney, which in a notable distance beneath the Kidney did enter into the Uritidian pore risen from the aforesaid Kidney, and both of them by one channel did reach into the Bladder; nevertheless this Emulgent artery did also enter into the Kidney in his wonted place; and in that individual the Kidneys were continued, as if it were one kidney; and it had two Veins, and two Emulgent arteries, and two Uritidian pores with one only Pannicle involving, which did take up the wonted places of the Kidneys, and also the middle part of the Back, which is in the place between the Spleen and the Liver, a little below them.

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CASTIGLIONI, A. (1945), *Ciba Symposia*, vol. 7, pages 70, 77, 84 and 91.

LARKEY, S. V. and TUM SUDEN, L. (1934), *Isis*, vol. 21, page 57.

GALL-STONE ILEUS

By R. H. STANISTREET
Royal Melbourne Hospital

INTESTINAL obstruction caused by gall-stones is uncommon. In a ten year period, 1942-1951 inclusive, there were 5 cases treated at the Royal Melbourne Hospital. When first encountered it is usually thought in this type of obstruction, with no threat to the blood supply of the bowel, that the mortality would be low. As is well known, this is not the case; 3 patients in this series succumbed, and this same high mortality has characterized other series reported. Because of the small number of cases, no statistical conclusions can be drawn, but some causes of this high mortality become apparent when the individual cases are analyzed.

During this time, repeated inflammatory episodes in the gall-bladder cause the formation of adhesions which bind the gall-bladder to the closely related anterior wall of the first and second parts of the duodenum (Fig. I). With the fundus of the gall-bladder adherent to the duodenum, the one or two large stones within the gall-bladder ulcerate into the bowel and the resulting fistula between the gall-bladder and the duodenum remains (Fig. II). The exact mode of the formation of this track is not known, but the action of the digestive ferment on the damaged duodenal wall is suggested as a contributory cause.

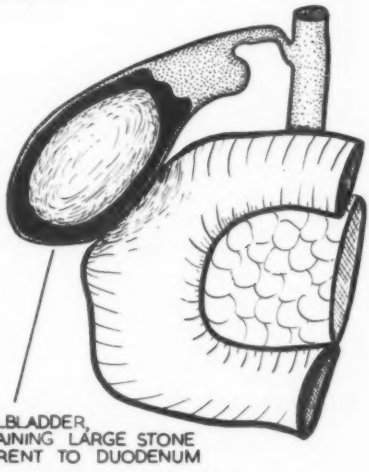

FIG. I. Drawing to show the stone in the gall-bladder, which is adherent to duodenum.

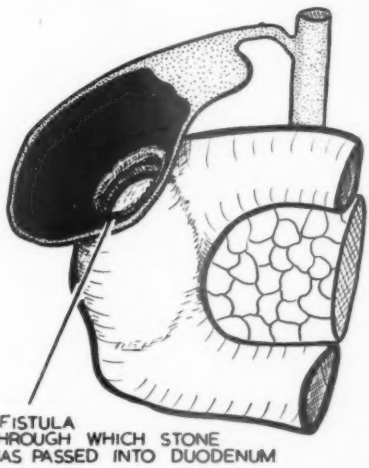

FIG. II. Drawing to show passage of gall-stone into the duodenum through a fistula.

Mechanism of Obstruction by Gall-Stones

In 4 of the 5 cases reported here there had been a long history of biliary dyspepsia. Flatulence, fat intolerance, and episodes of pain with a distribution characteristic of gall-bladder origin preceded the obstructive attack. One patient had an attack of biliary colic followed by jaundice eight months before ileus developed.

The large stone passes along the small intestine, and at operation is usually found in the lower ileum (Fig. III), some short distance from the ileo-caecal junction (4 cases); in 1 case the stone had passed into the caecum. The stone is about 5 cm. long and 3 cm. wide and cholesterol in type. The

bowel above the stone is distended but not grossly so and below it is collapsed; it appears quite healthy where it is immediately related to the stone.

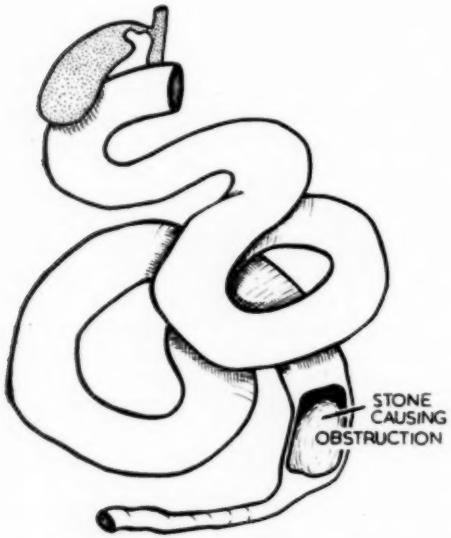

FIG. III. Drawing to show the gall-stone obstructing the small intestine.

Clinical Features of Gall-Stone Ileus

The average age in this series is 61 years, and 4 of the 5 patients were females. This conforms with other published series and cases.

As noted above, there was a preceding history suggestive of biliary dyspepsia in 4 cases; and in each of these cases there was an exacerbation of the symptoms just before the onset of the more acute symptoms.

When the stone enters the small bowel it might be anticipated that the onset of symptoms would be dramatic, and each case in this series complained of the sudden onset of severe epigastric pain, colicky in nature, which was soon followed by profuse and persistent vomiting. But obstruction was not complete, so that the symptoms subsided only to recur with renewed vigour after several hours. The vomitus became bile-stained and soon faecal. This persistent and profuse vomiting exacted its toll from the elderly patient causing dehydration and salt depletion, and the apathy and listlessness which followed, together with the intermittent nature of the illness might have been responsible for the delay (three to five days) before seeking medical aid.

All the patients were dehydrated on admission, with clinical evidence of salt depletion and acidosis. The breath smelt strongly of "faecal" vomitus. The abdomen was not grossly distended in any case, and in none was any rigidity present. The abdomen seemed generally tender, but most pain was caused by pressure in the epigastrium, under the right costal margin, or in the iliac fossae particularly the left.

A tube inserted into the stomach aspirated large amounts of fluid; and when a straight X-ray photograph of the abdomen was taken, dilated loops of small intestine with fluid levels were apparent. The stone was not visualized in any case in this series but is seen occasionally as an opaque shadow.

Treatment of Gall-Stone Ileus

These elderly patients usually have some concomitant disease such as degenerative cardio-vascular disease, obesity, diabetes, etc., and when the dehydration caused by the gall-stone obstruction is superimposed, their general condition requires urgent resuscitation. Intravenous therapy including the careful administration of saline and perhaps blood plays an important role. A tube should be passed into the stomach and regular aspirations begun. The patient should not be hurried to the theatre as the surgeon is not dealing with a strangulated obstruction.

The operation can be performed under local anaesthesia; if the general condition of the patient permits administration of a general anaesthetic, the most satisfactory appears to be a pentothal induction, combined with flaxodil and maintained with nitrous oxide and oxygen by means of endotracheal intubation.

The incision will depend on the preference of the surgeon; in most cases a paramedian incision is used. The stone is easy to locate

and the segment of the bowel which contains the stone is brought to the surface. The wall of the intestine is incised longitudinally, the stone extracted and the wound sutured transversely. The surgeon looks for a second stone in the bowel before closing the abdomen: removal of a facetted stone should always cause him to seek a second one.

DISCUSSION

The high mortality in this series is not unique; most reports of gall-stone ileus show the same high death-rate.

Two patients in this series died from peripheral circulatory failure, indicating the severity of the dehydration. The third case died from acute gastric dilatation.

TABLE 1

TABLE TO ILLUSTRATE MAIN FEATURES OF CASES REVIEWED

No.	Sex	Age	Previous History	Present Illness					Result
				Onset	Duration	Principal Symptoms	Principal Signs	Operative Findings	
1	F	73	Eight months biliary colic with jaundice	Sudden	Two days	Central abdominal, colicky pain, vomiting and constipation	No rigidity. Tender left iliac fossa. Bowel sounds audible	Gall-stone, large, had entered the cæcum. Cæcotomy	Discharged home and two years later cholecystectomy and closure of duodenal fistula
2	F	53	Two months flatulent dyspepsia	Sudden	Five days	Generalized abdominal, colicky pain, profuse vomiting, constipation	No rigidity. Tender in the epigastrium	Gall-stone 5 cm. x 3 cm. in lower ileum. Enterotomy	Discharged home well. Two attacks of intestinal obstruction subsequently due to "adhesions"
3	F	64	Years of .. flatulent dyspepsia with biliary colic	Sudden	Three days	Generalized abdominal, colicky pain, profuse vomiting, constipation	No rigidity. Tender in iliac fossæ	Gall-stone, large, 12 cm. from ileocæcal junction. Enterotomy	Death fifth post-operative day. Peripheral circulatory failure and right basal pneumonia. Autopsy: Fistula opening between duodenum and gall-bladder, 2 cm. in width. Gall-bladder small, fibrosed and empty
4	F	53	Four years flatulent dyspepsia	Sudden	Three days	Generalized abdominal, colicky pain, profuse vomiting, constipation	No rigidity. Tender in left iliac fossa	Gall-stone, large, in terminal ileum. Enterotomy	Death seventh post-operative day. Acute gastric dilatation and left basal pneumonia
5	M	64	No dyspepsia	Sudden	Two days	Generalized abdominal, colicky pain, profuse vomiting	No rigidity. Distended abdomen. Tender in hypogastrium and left iliac fossa	Gall-stone, large, lower ileum. Enterotomy	Death 18 hours after operation. Peripheral circulatory failure. Pulmonary infection. Autopsy: 2.5 cm from pylorus, there was a wide opening in the duodenum leading into the gall-bladder

Post-operatively the resuscitative measures which were introduced before surgery are continued until bowel sounds return and there is evidence that the bowel function is returning to normal.

Some surgeons advocate a further operation subsequently to remove the gall-bladder. This was done in one of these cases. Such a procedure is probably unnecessary, however, as it is apparently very uncommon to find the patient suffering from a recurrence of gall-stone trouble.

Nemir (1952) had a series of 8 cases, with one death. These cases were seen in the Hospital of the University of Pennsylvania between December, 1939, and February, 1951. In the fatal case the stone was found at post-mortem examination. Foss and Summers (1942) reported a case in which a second stone overlooked at the first operation was responsible for death on the eighth post-operative day; Janes (1953) reports a further case in which two operations were necessary within a week for two separate stones. Therefore, the surgeon must be sure

that all stones have been removed at the initial operation; a missed stone may be an important factor contributing to the high mortality.

The long delay before surgery in these elderly patients is probably another important cause of morbidity and mortality. Vomiting small intestinal contents for several days, in the absence of any fluid intake, both dehydrates and upsets the electrolyte balance of the body; and the elderly patient may not have the same reserves or the same compensating mechanism as the more youthful patient.

SUMMARY

Five cases of intestinal obstruction due to a large gall-stone are reviewed. One patient died of "acute gastric dilatation"; persistent vomiting after the initial operation may indicate a second stone. The surgeon should be careful to exclude multiple stones at the first operation.

Two patients died of peripheral circulatory failure; the greatest care is necessary in the resuscitative support both pre- and post-operatively.

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FOSS, H. L. and SUMMERS, J. D. (1942), *Ann. Surg.*, vol. 115, page 721.

JANES, L. (1953), *Aust. N.Z.J. Surg.*, vol. 23, page 77.

NEMIR, P. (1952), *Surg. Gynec. Obstet.*, vol. 94, page 469.

INTESTINAL OBSTRUCTION DUE TO IMPACTED GALL-STONES

REPORT OF A CASE

By Lois Janes

Royal Melbourne Hospital

INTESTINAL obstruction due to a gall-stone impacted in the small intestine is not common. In the case reported here, a second operation was necessary eight days after the first; at both operations a gall-stone was found in the ileum, and causing intestinal obstruction.

Case Report

Mrs. P.H., a very obese woman, aged 63 years, gave a history of attacks of typical biliary colic for fifteen years. The pain was accompanied by vomiting and usually lasted about forty-eight hours. She had never been jaundiced. She also complained of having had flatulence after meals and fat intolerance. Twelve months previously she had been admitted to hospital for cholecystectomy; but after the skin incision had been made the patient became cyanosed, without obvious cause and the operation was abandoned.

Examination showed the patient to be a very obese but dehydrated woman (15 stone 3 pounds). She was afebrile and her pulse rate was 100. Any degree of abdominal distension was difficult to assess because of the obesity. There was a generalized tenderness, particularly in the hypogastrium. No mass nor viscus could be palpated. Bowel sounds were present. The old Kocher incision and a right paramedian scar (ruptured ectopic pregnancy twenty-six years ago) were intact.

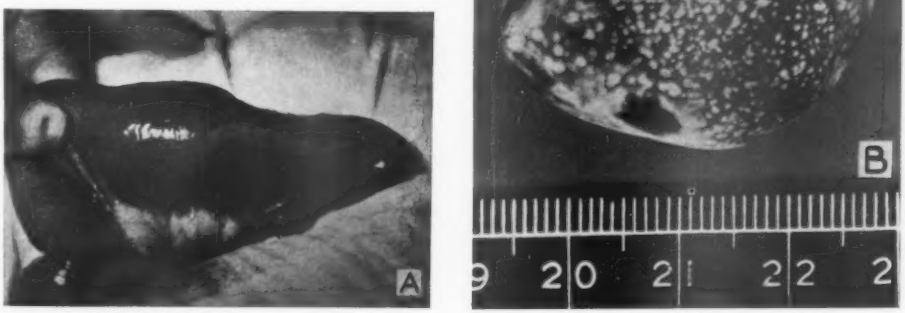


FIG. I. Findings at the first operation.
(a) The outline of the stone in the terminal ileum.
(b) The stone alongside a centimetre scale.

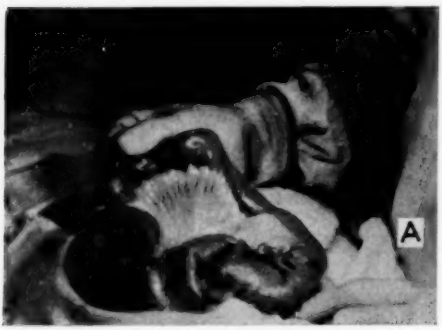
On the 31st October, 1952, she was admitted to hospital with a further attack of pain. It had begun three days previously and was of the accustomed nature. But twenty-four hours before admission, she suddenly developed a bearing down pain in the hypogastrium, more severe on the left side. The pain continued under the right costal margin. She vomited at frequent intervals. Her bowels had not been opened for the three days, although she had passed a small amount of flatus.

A provisional diagnosis of gall-stone ileus was made, but, in light of her past intolerance of anaesthesia and her present dehydration, it was felt that her general condition should be improved before embarking on any surgery.

Over the next two days dehydration was largely corrected, following intravenous therapy, but the pain and vomiting persisted and the vomitus had

become faecal in nature. A straight X-ray examination of the abdomen showed dilated coils of small intestine with numerous fluid levels.

On the 3rd November, a laparotomy was performed through an oblique incision in the right iliac fossa. The gall-bladder area was palpated and was found to be the site of dense adhesions; the small intestine was dilated, but not grossly; it was traced down to the terminal ileum where it suddenly narrowed. At the transition, there was a large gall-stone about 3 cm. in diameter. The stone was removed through a longitudinal incision in the bowel which was then sutured transversely. The stone possessed a single smooth facet (Fig. 1a, b).



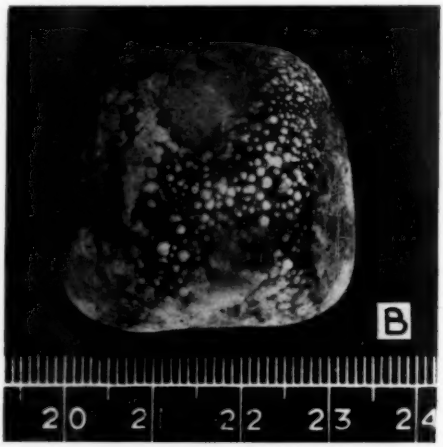


FIG. II. Findings at the second operation.
(a) The outline of the stone in the terminal ileum, 15 cm. below the first enterotomy wound.
(b) The stone alongside a centimetre scale.

Her condition rapidly improved, and on the 4th post-operative day she commenced a light diet. Apart from a wound infection she was otherwise well.

On the 6th post-operative day, there was a sudden recurrence of colicky abdominal pain and vomiting. She was treated conservatively for two days but failed to respond satisfactorily; on the 11th November a further laparotomy was performed, through a right paramedian incision. A second gall-stone was found impacted in the ileum 15 cm. below the previous suture line (Fig. IIa). The gall-bladder area was again palpated, and although fibrosis still prevented a thorough examination it seemed that no stones were now left in the gall-bladder; the second stone was similar to the first, and like it, exhibited a facet on the surface (Fig. IIb). The two stones placed together formed a cast of the gall-bladder.

Her convalescence was uneventful apart from some mild infection of the wounds. Three months later the patient was well and had had no further attacks of pain.

SUMMARY

A case of intestinal obstruction due to impacted gall-stone is presented. The case is unusual in that two gall-stones, which together formed a cast of the gall-bladder, each produced episodes of intestinal obstruction, the second attack within ten days of the first.

ACKNOWLEDGEMENT

I would like to thank Mr. R. Inglis for some of the photographs illustrating this case report.

Books Reviewed.

CANCER IN GENERAL PRACTICE.

By RONALD W. RAVEN, O.B.E., F.R.C.S., and P. E. THOMPSON HANCOCK, F.R.C.P. London: Butterworth and Co. Ltd., 1952. 8¾" x 5½", ix plus 265 pp., 71 illustrations. Price: 43s. 6d.

A well worth-while little book designed to assist practitioners (especially surgeons) in the responsible tasks of cancer detection and management. The work bears a pronounced surgical "twist," imparted, no doubt, by the senior author who is surgeon to the Westminster and Royal Cancer Hospitals. Australians will be pleased to note the frequent references to the pathological work of Professor R. A. Willis.

The subject matter is presented in thirty-three chapters, each chapter dealing with a nosological entity, classified on an anatomical basis. All chapters more or less follow a stereotyped pattern built up of sections thus: precancerous lesions, description of early lesion, development of the disease, early symptoms and signs, treatment, end results, etc.

Throughout the book, emphasis is placed upon early diagnosis. The authors, intent upon the cultivation of an alert and well-informed profession, are mainly concerned with clinical technology but they tacitly admit that early diagnosis, as a problem in social medicine, is primarily governed by the axiom that initiative always rests with the patient.

The survey of cancer in London hospitals conducted by the British Empire Cancer Campaign (1938-39) showed that in 15 per cent. of cases, no doctor had been consulted prior to coming to hospital. Of 12,125 patients who consulted a doctor, 68 per cent. were referred to hospital at once and 2 per cent. were told there was nothing serious the matter.

Patients kept under observation by the doctor for more than six months were chiefly those afflicted with cancer in regions where the diagnosis is often difficult in the early stages. Fully aware of these facts, Mr. Raven, who was connected with the British Empire Cancer Campaign survey, might well add a general introductory chapter to any future editions of this book, thereby giving readers a proper sense of proportion concerning the frequency and social significance of the major types of cancerous disease.

SURGICAL CARE.

By R. W. RAVEN. Second Edition. London: Butterworth and Co. Ltd., 1952. 8¾" x 5½", xii plus 435 pp., 68 illustrations. Price: 52s. 6d. net.

This book is a second edition, the first edition being published in 1942. The material has been brought up to date and covers the whole field of pre-operative and post-operative treatment of surgical patients. The first portion of the book is concerned with aspects of general surgery such as shock, haemorrhage, water and electrolyte balance, burns, etc. Following this are chapters on the surgery of various organs. In this portion of the book there is some repetition because of the similarity in pre-operative and post-operative treatment in many abdominal conditions. The subject matter is well arranged and accurate and there are a number of good illustrations.

This book will be particularly helpful to house-surgeons and surgical registrars since it elaborates a phase of surgery not found in the usual text-books. The student will find the first portion of help because of the attractive method of presentation but the latter portion will be of little use since only a limited field of the surgery of various organs is discussed. The practising surgeon should be well aware of the material presented.

This is a book which can be recommended to house-surgeons and to trained members of the nursing profession interested in the care of surgical patients.

MODERN TRENDS IN GASTRO-ENTEROLOGY.

By F. AVERY JONES. London: Butterworth and Co. Ltd., 1952. 10" x 7," xiii plus 831 pp., 275 illustrations. Price: 140s. net

Gastro-enterology is the branch of medicine where active co-operation of physician and surgeon is so necessary. Unlike most other branches of medicine it provides a common meeting ground as well for the physiologist and anatomist, for the biochemist and pathologist. Without the help of the radiologist and psychologist a great amount of recent work in this field would not have been possible. Nonetheless, a large number of its problems still remain to be solved despite the growth of experimental work in this field. It is still not considered as a separate specialty in British countries though it has seceded from general medicine in America.

It is therefore very timely for a book to appear expressing British views on this subject. This is not an attempt to decry American text books on gastro-enterology, but to issue a warm welcome to one that maintains British standards of discrimination and critical analysis. Modern Trends in Gastro-enterology as its name implies is not a complete text book on the subject but concentrates on those aspects which have been advanced by recent work. At the same time a nice balance has been kept between experimental work and clinical detail. The selection of chapters could have been no easy task for the editor and he is to be congratulated on the results achieved.

There are 34 chapters, every one of which is well worth reading, but some are outstanding. The detailed discussion on hiatus hernia is a masterly presentation of the subject. The author has largely followed Allison's ideas and freely acknowledges this. Peptic ulcer is dealt with in great detail as befits a disease which has become such a common medical and economic problem in recent decades. It is to be expected that this symposium on ulcer would be so comprehensive in a book edited by a man who has achieved an international reputation in this field. The opening chapters on anaemias of the

alimentary tract and the relation of the alimentary tract to cardiovascular disease will be of particular interest to the clinician. At the same time the chapters on the vascular anatomy of the stomach, gastric secretion, fat absorption and gastro-intestinal motility allow the clinicians to keep abreast with more academic aspects of gastro-enterology. It is a nice compliment to Australian medicine that five of the contributors are Australians and two of the sections, Gastric Biopsy, and Megacolon, report their original work on these. The volume finishes with an excellent discussion of modern views on pancreatitis.

Even in a book of its size it was inevitable that some sections had to be reduced but one cannot help feeling that the growing experimental field of liver disease could have received a little more attention. Sheila Sherlock's statement that the proliferation of reticulin in the liver in chronic venous congestion and the "reversed lobulation" which follows, constitute cirrhosis even if prefaced by the word cardiac will not find general acceptance among pathologists or those working on the problem of liver disease. Generally it has been very difficult to correlate the duration of venous congestion with definite liver changes. The statement by Sherlock that "iron in excess is toxic to liver cells which disintegrate" suggests that her experience of biopsy material in this disease must be limited. Liver cell degeneration, apart from fatty change due to malnutrition, has not been seen in numerous biopsy sections here. However, these are minor criticisms.

This is a book that cannot be too strongly commended to all physicians and surgeons who have anything to do with gastro-enterology. It will fill a long felt need for post-graduate students and will be a very good reference work for undergraduates.

This book is a credit to British medicine and great praise is due to the editor and Messrs. Butterworths for the excellence of the production.

CORRELATIVE NEUROANATOMY AND FUNCTIONAL NEUROLOGY.

By J. J. McDONALD, M.S., M.Sc.D., M.D., and J. G. CHUSID, A.B., M.D. Sixth Edition. U.S.A.: Lange Medical Publications, 1952. 10" x 7¼", 263 pp., 173 illustrations. Price: $4.00.

Of all the aspects of human biology, that of neurology is most suited to be discussed as an entity rather than from the two view points of anatomy and physiology. It is therefore refreshing to find such a publication as "Correlative Neuroanatomy" by McDonald and Chusid, emphasizing this fundamental relationship. The title of the 6th edition has now been changed, and several new chapters have been added, more detailed reference being made to clinical aspects under chapter headings such as syncope, headache and aphasia, and to such important matters as muscle testing.

The diagrams and tables used are well prepared and clearly set out and as such provide a very effective demonstration of the material discussed. While realising the difficulties of dealing with this subject in a way which will appeal to beginners, it is felt, however, in some sections, particularly the table showing segmental motor supply that an unwarranted impression of inflexibility is given.

The publishers show their appreciation of student needs by retaining the cheap, but effective, methods of binding and reproduction used in previous editions. Even so, the price in America of 4 dollars sounds a warning note that the purpose of the book may be defeated.

BIOLOGICAL HAZARDS OF ATOMIC ENERGY.

Edited by A. HADDOW. Oxford, England: Oxford University Press, 1952. 9¼" x 6", xii plus 236 pp., 17 plates, 67 figures. Price: 63s.

This volume is a report, in detail, of the proceedings of a conference convened by the Institute of Biology and the Atomic Scientists' Association. Knowledge in this field of physics and in its influence on biology is advancing so rapidly that text books of the conventional type are out of date by the time they are published.

Attempts are being made in both Britain and America to overcome this difficulty by producing, in monograph form, proceedings of this kind. We thus find a collection of papers by different individuals on quite different though, of course, related subjects. The disadvantages of the presentation together of different viewpoints and quite different material is, of course, offset by the obvious advantages of having an up-to-date statement on each part by a specialist in the subject.

In the present volume there is a foreword by Sir Henry Dale and the actual contents itself ranges from specific problems such as the "Biological Response to Penetrating Radiations" through such practical problems as the "Hazards in the Clinical use of Radioiodine" and of "Radioactive Strontium" to such general problems as the "Long-term Genetical Hazard of Atomic Energy" and the "Scientist's Responsibility as a Citizen."

The various chapters make fascinating reading and clearly indicate the difficulty in keeping pace with the advances in a modern world. At the same time such a presentation as this makes one feel that it is almost possible to maintain a nodding acquaintance with such recent advances.

There is here a mixture of fundamental physics and related chemistry with the more familiar (to the practitioner) pathological and clinical considerations.

The book is well produced and the illustrative plates are very clear. There is a good author and subject index. The monograph will be of great interest to all who wish to keep abreast of recent advances in atomic energy in relation to biological processes.

Books Received.

PSYCHOLOGY.

By WILLIAM McDOUGALL. Second Edition. London: Oxford University Press, 1952. 6¾" x 4¼", xix plus 191 pp. Price: 7s. 6d.

EMERGENCY SURGERY (Part V).

By HAMILTON BAILEY, F.R.C.S., assisted by N. M. MATHESON, F.R.C.S. Sixth Edition. Bristol, Eng.: John Wright and Sons Ltd., 1953. 10" x 6½". 180 pp., 241 illustrations. Price: 21s.